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IN ALL THEIR DEPARTMENTS.

ECONOMIC GEOLOGY.

ON THE MECHANICAL STRUCTURE OF SOILS.

If the external covering of our planet was removed, so as to lay bare the framework of its surface, and expose it to the influence of those physical agencies which appear to be momentarily altering its external aspect, what would be the progress of adaptation which its surface would undergo to fit it for the reception of man, and the production of those articles on which he subsists? A complete solution of this problem would show in what way the most fertile soils have been brought to their present condition, the component elements of which they are constituted, and the state of mechanical division and chemical aggregation which subsist together in order to constitute them what they are. It is only by the imitation of the laws of nature that man can expect to produce her results.

We shall first consider some of those conditions of soil which seem most essential to luxuriant vegetation; we shall then be better able to consider and estimate the circumstances which produced them, and also to imitate them, or set to work natural processes to do so.

The fertility of soils depends then on a variety of conditions and circumstances, so that a soil of considerable fertility in one situation might be sterile in another, and *vice versâ*, that is, as far as their constitution is concerned. It is evident that a soil which occupies a rapidly sloping situation should be more retentive of moisture than one which covers a level plain, and also one resting on impermeable clay or rock should differ from one reposing on gravel or a porous subsoil. This necessary difference arises not only from the more or less permeable nature of the subsoil, but also from its more exposed situation, and from the greater liability of the water to run off under such circumstances than the other.

Not only must soils be permeable by, and retentive of, water, but also permeable by air. This is the agent by which all the most important changes in the constituents of organic matter are principally effected, and fitted to be assimilated by their organs, fromthe first germination of the seed to the mature growth of the plant. The constituents of manures are rendered soluble, carbon becomes carbonic acid gas, and is then in a fit state to be absorbed; this evidently results from the oxygen of the atmosphere being in a free state, and constantly ready to be combined with all those constituents which it comes in contact with, and for which it has an affinity.

There is still another agent, whose influence is not less necessary to vegetable development, and this influence depends in an important degree also on the constitution of the soil. If the interstices of the soil are filled with water, the first influence of the sun in spring will be long employed in converting this into vapour before the soil can be much warmed. This most important influence will be long lost before its effects are felt in giving energy to vegetable life, for it is a well-known fact that a great amount of heat is rendered latent by the conversion of water into vapour. The colour of soils also has a considerable influence in relation to heat: black, for instance, is about four times more heated in the same time than any other, but it appears to be not quite so retentive. Some of the conditions then that obtain in a good soil are the following. It must be permeable by air and water, and highly retentive of the latter. And here it must be observed, that there is a great difference between a soil which is retentive of moisture and one which is so saturated that the water might be pressed out with the hand. When apparently dry, soils should contain from $\frac{1}{15}$ to $\frac{1}{12}$ of their weight of water, and this is so intimately mixed with them, that a high temperature is required to free them completely from this admixture. Now, this property of retaining moisture results chiefly from the minuteness of the particles of which the soil is composed: if these be large it will retain very little, and this will be dissipated into the state of vapour in a few hot days. This is principally the cause of the sterility of sands. Again, while this retentive property of a soil depends upon the component particles, its permeability by air depends chiefly on the opposite: there will therefore be a due degree in which they must exist together, to render a soil in the highest degree fertile. It is also evident in what way the draining of dense subsoils acts, and also its utility where porous, as the soil must be emphatically cold when it is constantly saturated with water. But this also may be in the extreme; if a subsoil be too open and loose, all manure and the most valuable part of the soil will be carried away, and this will emphatically constitute a hungry soil.

Soils have frequently been analysed, and inferences drawn from their constituents have differed materially from the truth. We do not mean to state that the quantity of the different earths in a soil is quite a matter of no importance, but, compared with the size and proportion of the different particles of a soil, it is by no means of the greatest consequence. It is the very minute size or impalpable state of the particles of a soil that renders it retentive of manure and moisture, and it is the presence of larger particles which renders it permeable by air and water. It is true that the particles of calcareous, and especially of aluminous earths, are generally in this impalpable state, with a portion of siliceous earth, and then its effects are nearly the same. On looking over the analysis of soils reputed highly productive, it is surprising to find how widely they differ in their constituents; a few are selected from Sir Humphry Davy's Agricultural Chemistry: Calcareous earth $\frac{3}{4}$ to $\frac{1}{20}$, aluminous ditto $\frac{1}{2}$ to $\frac{1}{20}$, siliceous ditto $\frac{1}{2}$ to $\frac{1}{20}$; and, generally, chemical analysis is not necessary to ascertain the quantity of the different earths, for, unless they are palpably abundant, it does not appear to be of great importance; hence, practical agriculturists, judging from the mere appearance of soils, have sometimes formed truer conclusions than chemists, judging from the constituents.

Having now briefly considered some of the principal conditions of fertility in soils, we shall return to the point from which we set out. And, first, what effects would have followed the influences of physical agencies, such as we have supposed. Such agencies of

course have always existed, but they acted originally with more of youthful vigour, while the effects we now see are those of an infinite series, whose first terms have been constantly exhausted by the constant subtraction of some expended power. When we view recently exposed strata, we see its surface indented with numerous hollows and furrowed by various ridges, and where these are sharp and well-defined, we may infer that it has been subjected to little of the abrading influence of the atmosphere. This, no doubt, presents a miniature picture of the earth's surface before it was clothed with the various earths which now give it that beautiful flow of outline and gradual descent from hill to valley. Some of the masses which are now seen as hills had probably all the features of the mountain districts, from which all soil has been carried away as fast as formed. Others again having been disrupted from beneath, or covered by volcanic agencies with the products of igneous action, their surfaces would be in a condition to be pervaded by meteoric influences.

Most rocks contain iron in the state of protoxide, and as air and water come in contact with this, there would be a tendency in the iron to enlarge its volume by uniting with a larger portion of oxygen, so as to become peroxide, and this tendency is exerted with so great a force as to detach particles from rocks containing iron. Water also enlarges its volume with a similar power; when frozen, its volume is increased about $\frac{1}{12}$, and as it permeates all porous rocks more or less, the degree of disintegration resulting from it would be considerable. Winds, too, assist in the work of comminution by driving particles with violence against rocks and each other. But it is to watery agency in the form of floods, waves, currents, tides, and rains, that we must chiefly look for a modifying influence on the past condition of our globe. That large portions of it have been permanently submerged is quite evident from the water-worn appearance of the sides of some mountains containing caves, fissures, and an appearance perfectly similar to the cliffs of the sea shore, and further from the universal prevalence of rounded portions of the various rocks. The origin of this superficial covering of our earth is therefore clearly referrible to such causes for its existence in this state of mechanical division.

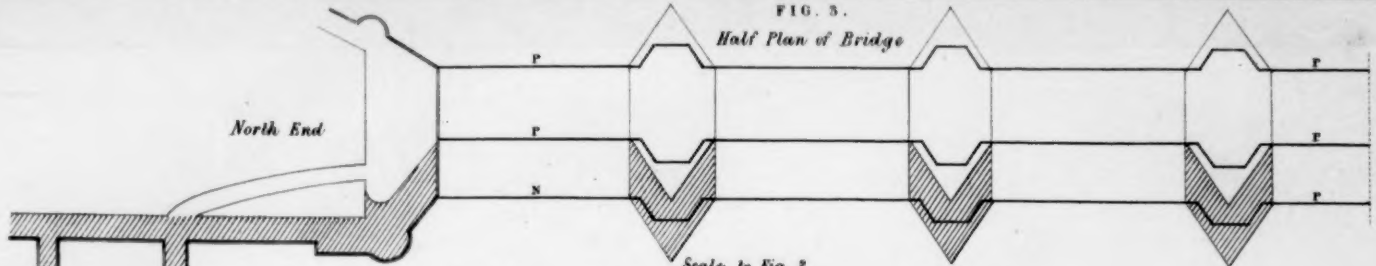
There is yet one general constituent of soils of which we have said nothing: it is that substance which results from the decomposition of organic structures, and which has been called humus, vegetable-earth, &c. Some portion of it is essential to great fertility; this portion, however, admits of great latitude, from a mere trace to a considerable proportion, but about 8 or 10 per cent. appears to be the best.

In a natural course of vegetation there is a tendency to increase this constituent beyond the extent essential to vigorous vegetation; and hence the existence of peats, morasses, &c., which are prevented from further decomposition by the presence of tannin, also a vegetable product. In this state vegetable earth is quite inert as manure. Soils may, however, be freed from this principle, because tannin is soluble in water, when free, and caustic lime has a greater affinity for the earth than for the tannin; therefore, by mixing with lime the organic matter is rendered free from the noxious principle called tannin. From these considerations it appears that the water draining from morasses must be injurious to vegetation, by preventing the decomposition of the organic matter on which their nourishment depends.

The solubility of the various constituents of rocks and earth presents also important relations to the growth of plants. We have already intimated the solubility of vegetable earth; but from the almost total dependence of vegetable growth on this, it merits further notice. Plants contain only a small portion of the other earths in which they grow, generally not more than $\frac{1}{20}$th part. When plants are subjected to combustion, it is a well-known fact that much of their substance is lost. The earths, however, are indestructible by a moderate heat, that is, the argillaceous, calcareous, siliceous, &c.; hence it is evident, that a very small portion of these are necessary to their growth as constituents; they furnish little more than a laboratory, in which is performed the chemical process of preparing matter to be received into the minute pores of the most minute roots of plants, where the vital process begins; and it cannot be too emphatically stated, that it is upon the food-preparing facilities of the soil, that the luxuriance of vegetable life depends. It would appear, that the quantity of humus in soils is usually quite sufficient to furnish materials for the growth of several crops, if the soil were rightly constituted, and the humus not combined with any substance which prevents its decomposition.

In relation to irrigation, three considerations are necessary:— 1st. If the water hold in solution any substance capable of improving the soil. Water dissolves lime, so that if it has passed through or over calcareous earths, it will, on being spread in a thin sheet over the surface of the ground, attract carbonic acid from the air, and carbonate of lime will be precipitated. This will improve the texture of all soils which are too loose and porous; but it must be observed, that there is a great difference between lime in this its neutral state and caustic lime; the latter has powerful affinities, which it exerts on humus, if present, by uniting with its carbonic acid, leaving the remainder in a soluble state. With the partly decomposed fibres of vegetable matter, such as roots and stems, it acts in a similar manner. Now where these sources of saturation are not at hand, it remains partly caustic in the soil, depriving the roots and germs of seeds of their support, and also absorbing carbon and oxygen from their living tissues. In the one case it is highly beneficial, in the other highly injurious. All applications of powdered limestone are similar to that supplied by irrigation, improving only the texture of the soil. 2ndly, if water hold suspended particles of the various earths under the same circumstances as the preceding, they will improve the condition of the soil in relation to its mechanical texture. But as vegetable earth and some salts are generally contained in the water, they will be deposited as the water percolates through the soil, and will act as manures. 3rdly, The supply of moisture which it furnishes is highly useful as a solvent. It has also been stated, that plants deposit by their roots a refuse portion of sap, which is injurious to the healthy action of their functions, and that irrigation removes this by washing the soil. The chemical and mechanical agents exerting their various physical powers, then, on the numerous rocks which constitute the surface of our globe, have decomposed some and abraded others, intimately mixing in some cases, in others aggregating them, and it is for man to perfect this process where nature has not done so. She has furnished him with sufficient specimens and materials in abundance. The decomposition of granite has furnished probably most of our clays, since felspar consists principally of argil, with about 14 per cent. of potash. Silica is abundant in almost every rock, and the calcareous earth is furnished by every form of carbonate of lime. Rivers rushing from elevated districts, loaded with the spoils of the rocks over which they had passed, and descending to a situation where the violence of their motion was diminished, would first deposit the heavy matter, and where the waters become still, the

FIG. 3.
Half Plan of Bridge



Scale to Fig. 3.

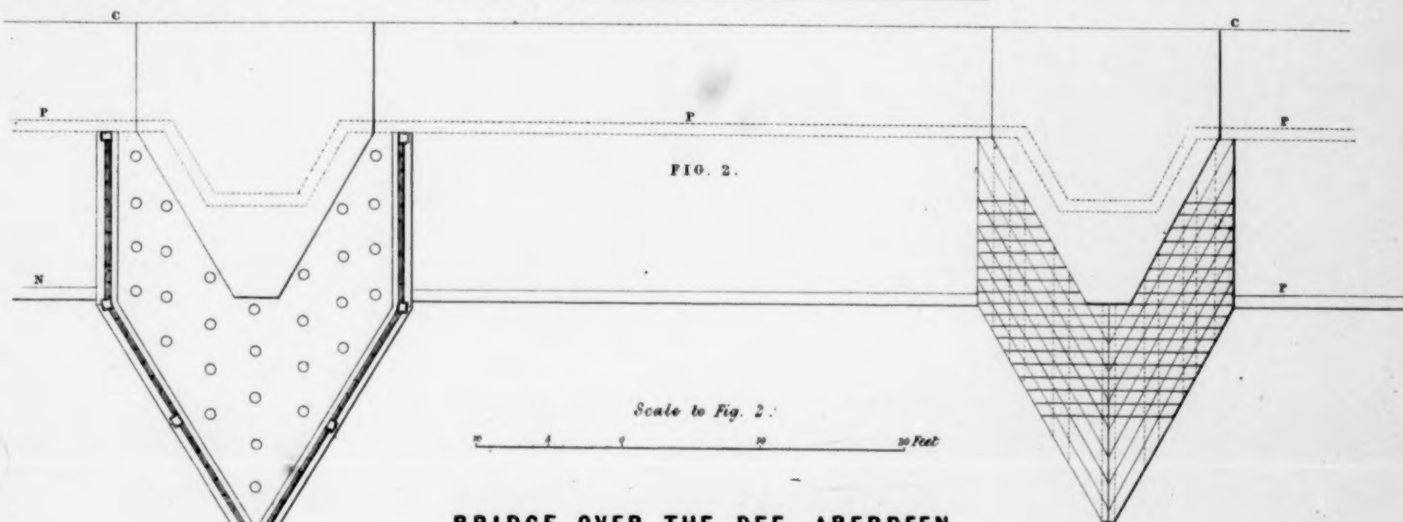


FIG. 2.

Scale to Fig. 2.

BRIDGE OVER THE DEE, ABERDEEN.

FIG. 4.

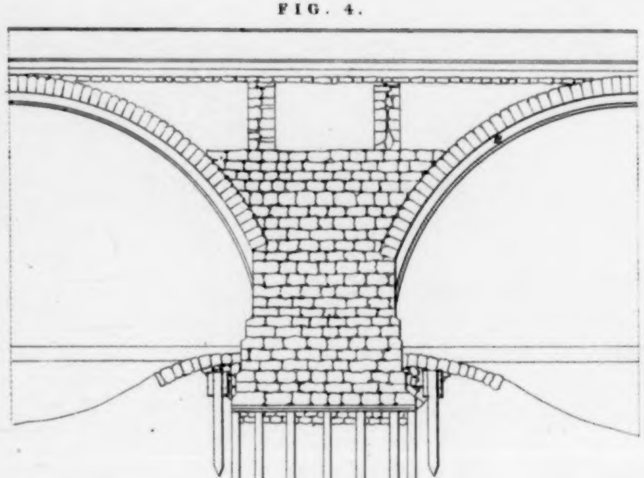


FIG. 5

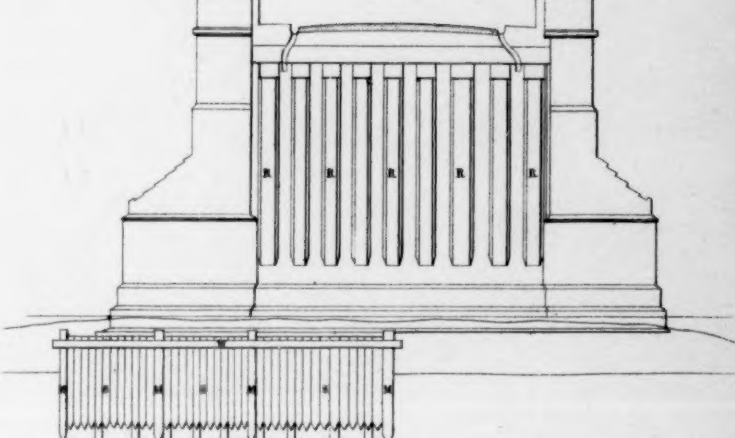
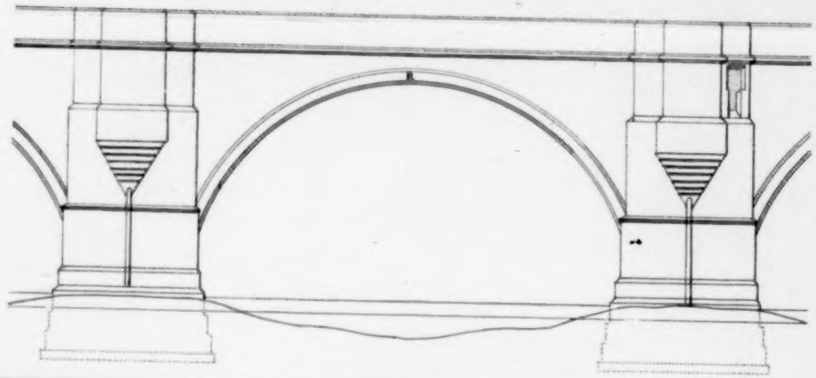
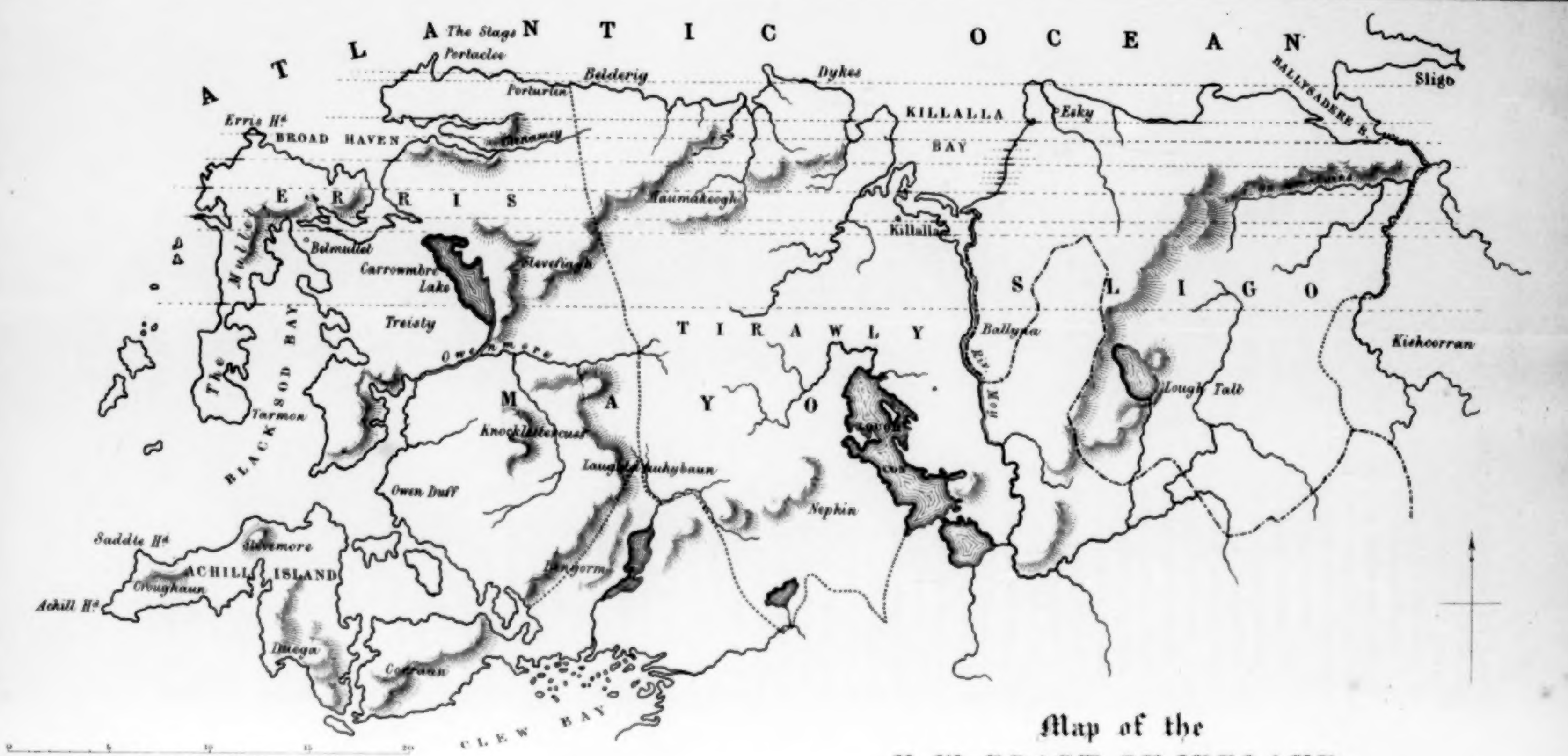


FIG. 1.



Scale to Fig. 1.

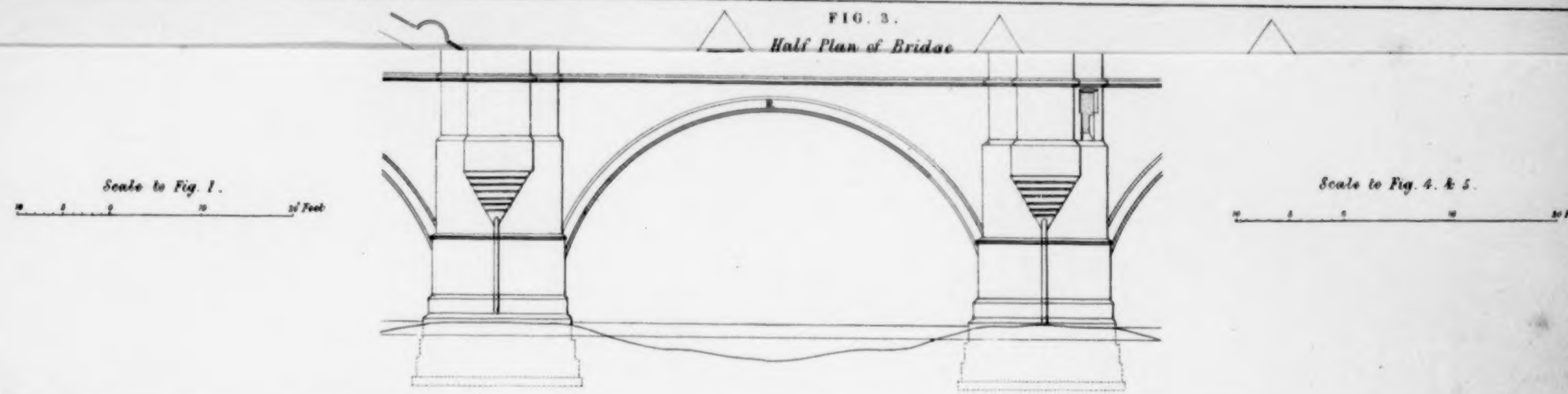
Scale to Fig. 4. & 5.

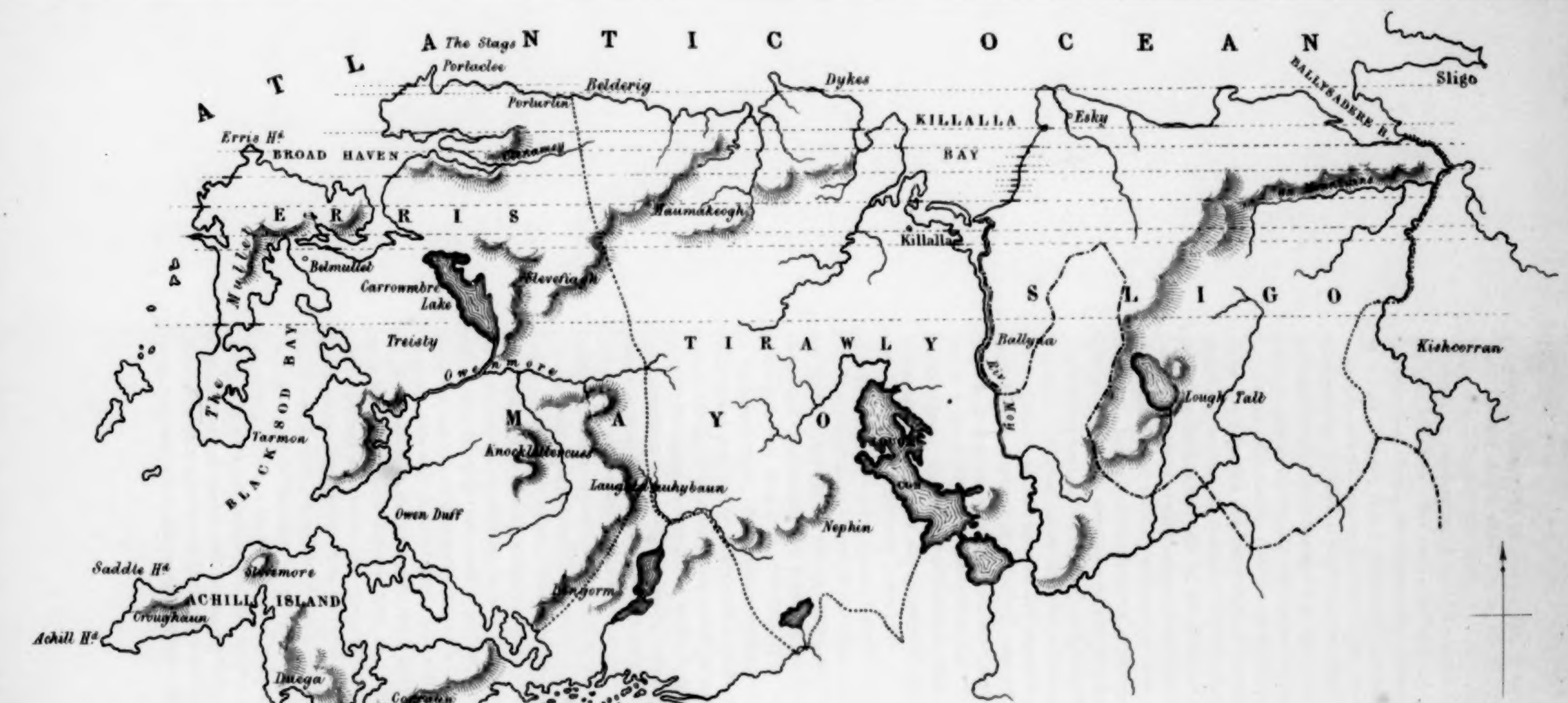


Map of the
N.W. COAST OF IRELAND.

FIG. 3.

Half Plan of Bridge





Map of the N. W. COAST OF IRELAND.

most minute. This is no doubt the origin of our alluvial plains, consisting of nearly all the earths in a most minute state of division; and the extent to which they crack when subjected to heat, shows the degree in which they retain moisture.

THE BRIDGE OF DEE.

The bridge over the river Dee at Aberdeen consists of seven equal semicircular arches, whose united span affords a clear waterway of 317 feet.

The present roadway over the bridge is exceedingly narrow and inconvenient, being something less than 15 feet in width between the parapets. In consequence of this, the provost and magistrates of the city determined, about the close of the year 1840, to widen the bridge to the extent of 11 feet 3 inches at one end, increasing to 11 feet 6 inches at the other end, making a clear width of 26 feet between the parapets. The designs were made by John Smith, Esq., the town architect, under whose directions the work is now in progress. In a letter with which we have been favoured from Mr. Smith within the last few days, he expresses his opinion that the bridge will be ready for opening to the public in October next. The following is the specification for the works :—

SPECIFICATION FOR WIDENING THE BRIDGE OF DEE.

The additional width is to be made on the west side of the present bridge, and is to be 11 feet 6 inches at the north end, and 11 feet 3 inches at the south, from the outside of the present west parapet, to the outside of the new one, as represented and marked on the plan; and the face line is to be perfectly straight between those points. The west round turrets, side of abutment and wing-walls belonging to the old bridge, part of starlings, and half octagons of piers and parapet, are to be carefully taken down. The cornice, the different escutcheons and inscriptions, and all the face or outside stones of the arches and spandrils, are also to be carefully removed and laid aside; and all the outside ashlar stones and panels of the present west side of the bridge and wing-walls, which are sound and good, are to be rebuilt in their places in the new façade, and all deficiencies made perfectly good with stones of similar quality and colour, whether of granite or freestone. A small part of the south wing-wall is to be left standing below ground, to act as a counterfort, only the face stones are to be removed from it. The iron railing and plinth on the present circular retaining wall at north end are to be removed; the wall reduced about 3 feet in height; the rubble face stones taken out for being rebuilt in the new wall, and the remaining part to be left standing.

The new masonry of the abutments and piers is to stand on piles and planking, and the foundations are to be laid at the depths shown on the section, fig. 4. Each of the piers is to have 29 bearing piles, averaging 9 feet in length, and 9 inches diameter in the middle, and each of the abutments is to have 24 bearing piles, averaging 8 feet in length and 9 inches diameter, and all to be shod with cast iron.

The tops of the piles are to be square cut and levelled, and on the top of each row there is to be a sill 9 inches broad by 4½ inches thick, strongly spiked to the heads of the piles with malleable iron, and to the depth of 10 inches under the pile-heads, and flush with upper side of sills; the space is to be filled with rubble masonry, laid in strong lime mortar. The sills, the top of which is to be about 2½ inches below the upper bed of the present planking of the foundations, are to be first closely covered with 3-inch planks laid obliquely to join with the present, and bedded on lime mortar; and over these, and across the present planking, so far as uncovered, another tier of 3-inch planks is to be closely laid, as represented, and bedded, and to be strongly spiked to the sills and to each other.

Round each of the extended piers and abutments there is to be a row of main and sheeting piles, as shown in the plan, fig. 2; the former are to be 10 inches square, those of the piers 11 feet in length, and of the abutments 9½ feet, and all shod as above stated: under the top of the main piles there is to be a waling on each side, the inside one 6 inches by 9 inches, and the outer 7½ inches by 9 inches, half checked on the ends, and strongly bolted through each of the main piles with four ½-inch malleable iron rag bolts, and leaving a space of full 4½ inches between them, through which the sheeting piles are to be driven. The sheeting piles are to be 4½ inches thick, those round the piers 8½ feet in length, and round the abutment 7½ feet, and in the middle of each of the spaces between the main piles, there is to be a strong 5-8th inch malleable iron bolt through the walings and sheeting piles, and the spaces between the bearing and sheeting piles are to be filled up and hard packed with rubble stones below, and laid in lime mortar above.

The piles are to be driven with a monkey engine, having a ram not under 800lbs. in weight, and the bearing piles are to be bottomed so that they shall not go down above $\frac{3}{16}$ths of an inch with two strokes of the ram at a fall of 12 feet.

The different piles may have to be more or less in length than above stated, in proportion to the quality of the ground, and will be paid for according to the schedule prices; but the calculations are to be made with the dimensions as specified and as shown.

The whole of the timber used in the foundations is to be of best hard full-grown fir from the forests of Aboyne, or other Deeside wood of equal quality; the piles are to lie straight and fair, and the bark stripped, and sills, planking, main and sheeting piles to be fully squared up.

All digging of foundations, forming of coffer-dams, pumping of water, and all necessary works for completing the plan, are to be performed, and all centering, scaffolding, service-wood, and every description of materials, utensils, and carriages required, are to be furnished.

The masonry of the foundations, abutments, and piers, is to be laid at the depth shown; but as the dimensions marked* are to the upper side of the present planking, it will be 3 inches less (the thickness of the new upper planking); the lower course on the parallel sides of the extended piers and abutments, is to have an offset of about 22 inches, and the other offsets are to correspond in breadth, height, and form with the present ones all round the starlings.

The masonry of the parallel faces of the extended piers and abutments, to the springing of the arches over the ribs, is to be of well pick-dressed and jointed ashlar, the stones having beds at least 18 inches in breadth, and not less than two feet in length, and to be

* The dimensions are omitted, as they would only tend to confuse in the accompanying plans and sections, which, it need scarcely be said, are on a considerably smaller scale than the original contract drawings.—Ed.

of an equal thickness throughout: one-eighth part of the surface is to be headers, not under 3 feet in length, and all close laid and bedded in strong lime mortar. The hearting of the above to the upper bed of the springers of the arches, is to be composed of large stones fairly dressed with the hammer on the beds and joints, all wrought into an equal thickness with the outside work, and laid so as to have proper bond with the same, and having headers among themselves, all to be hard packed with pinnings and lime mortar; and whenever a course is brought to a level, it is to be well grouted with thin lime.

The new outside stones of the above are to be of a good quality of granite, and as similar in colour to the present ones as possible.

There are to be four additional ribs in each arch, of best hard liver freestone from the quarries of Covesea* in Morayshire, polished† and champhered similar to the present ones, and to be of the dimensions shown on the section; and the stones forming them are to have fair and flush droved upper beds, close radiating joints, and all to be straight and fairly thrown, well built, and bonded into the piers and abutments, and to correspond in every way with the present ones.

The arches over the ribs are to be of granite, and the stones composing them are to be 18 inches in breadth of bed, and fairly pick-dressed to the radii of the curves, and also on the under side or soffit, and abutting joints, and the three lowermost courses on each side of the arches are to be tailed in to abut against the rubble hearting. Each course is to be of equal thickness throughout, and the stones are to be in lengths to reach from centre to centre of the ribs, all laid in good lime mortar, and well and fairly thrown and brought to their beds with a wooden mallet; the present outside champhered ringcourse is to be again used, as before stated, and the whole to be well grouted with thin lime mortar on the top. The faces of the starlings and semi-octagons of the piers and spandrils, abutments, turrets, wing-walls, and buttresses, with all their intakes and stringcourses, are to be closely and neatly built in their present form, and with the present stones, so far as they are sound and good, and will answer; only that the points of the starlings and projecting faces of the semi-octagons are to be averaged and made in a straight line; and all broken or faulty stones are to be replaced with new ones to match. The backing of the abutments and piers behind the arches, spandrils, semi-octagons, and wing-walls, is to be of good, well bonded, and packed rubble work, laid in regular courses in good lime mortar.

Interior cross and longitudinal spandril walls, as shown, are to be built between the different arches; and on the spandril next the abutments there is to be a similar cross wall and two longitudinal ones, all of rubble masonry as above described; and the spaces between them are to be covered with strong flat stones, not under 10 inches in thickness, jointed so that they shall be close together, and to be bedded and pointed with mortar, to form the bed of the clay-puddle; the spaces of the semi-octagons may be filled with gravel, and left uncovered.

The new masonry of the piers and abutments, &c., is to be well and carefully bonded, and all connections made good at the junctions with the old.

* The liver freestone of Covesea is a large-grained sandstone, of a whitish cream colour, procured in massive blocks, and remarkably well adapted for river and harbour works.—Ed.

† The polishing here specified, is effected by rubbing down the face of the stones with another piece of freestone. By this process the face is made very smooth, all marks of the tool are obliterated, and the stone has greatly the appearance of marble.—Ed.

The new straight retaining wall of the approach at north end, is as be built with the present face stones, and packed in lime mortar as before stated, and to average 4 ft. 4 in. in thickness; the present plinth of the railing may be dressed straight, and again laid; the bonrigs made good, and the pillar at the turret rebuilt; and a cast iron railing is to be furnished and securely put up and finished complete in every respect, similar to that in front of the water-engine house.

The cornice of the bridge is to be fresh droved or dressed; made good where deficient, and laid level, and water spouts repaired and placed. The parapet is to be well and neatly built, and made level on the top; the openings of the water-spouts and turret doors closed up, and the stone seats made good and rebuilt in the recesses.

The parapet on the east side between the different semi-octagons, and to the inner angle of the wings, is to be taken down; the greater part of the cornice taken up, and so altered, relaid, and new pieces made, as that the parapet may be built in a straight line, by being for the most part within the present outside face line, and the upper side of the cornice to form a levelled intake to the same of more or less projection, according to its present deviation from a straight line. The south and north sides of the semi-octagons are to be extended or made to join with the straight parapet, which is to be well and fairly rebuilt, and the whole to be made good, as on the opposite side.

The coping stones of the whole of the west parapet, and of the east one, so far as rebuilt, which may not have iron bats or dowels at present in their end joints, are to be furnished with inch dowels 3½ inches in length, of cast iron, and with the present ones to be run up and made fast with Parker's cement.

The embankment at each end of the bridge is to be formed with gravel, well punned as the work advances, and the metalling and surface of the approaches extended in width, and finished in a suitable and complete manner.

On each side of the bridge there is to be a foot pavement of well-picked, dressed, and jointed granite, 3 feet in width, in one stone, the outer edge of which is to be squared 2 inches down to form the kerb, and the recesses to be laid with similar pavement of good size, and all to be well bedded and grouted with lime mortar.

On the top of the new arches, spandrils, abutments, and octagonal recesses, there is to be a layer of good dry clay, averaging 6 inches in depth, laid on in two equal thicknesses, and well punned and equalized with stiff gravel on the surface, to form the under bed of the metal and foot pavement.

An angular channel is to be formed with five 6-inch well-dressed paving stones in breadth, along each foot pavement; four of these courses are to be 3 inches in breadth, and the middle or lowest 4 inches, and cut to a concave angle on the top, and to be well bedded and grouted with thin lime.

From the channels over the crown of each of the arches, there is to be a curved 4-inch cast-iron pipe passed through the arch stones between the ribs, as shown in fig. 5, having an extended flanged mouth-piece in the form of the channel and grating, 12 inches square over, all closely fitted in, and the channels to have declivities to the same.

The carriage-way is to be formed with a layer of small stones, about 4 inches in depth, set by the hand, and on the broadest ends, and well beat down, over which there is to be 8 inches of metal of hard and equal quality of granite stone, well and equally broken, so that no stone shall exceed 4 imperial ounces, laid on in three

separate layers, and each to be well rolled and incorporated with the side of the present.

The surface of the present metal on the bridge is to be picked up and equalized; a thin coat of new metal, say about 2 inches thick, put on, so that there may be a fair and equally curved surface from channel to channel, and to be binded with a small quantity of good gravel.

All lime used in the foundations, and to the height of the springing of the free stone ribs, or that average level throughout, is to be of the best Scotch shells from Lord Elgin's works*; for the rest of the masonry the above and good English shells in equal proportions are to be used; and for the hearting, backing, and interior spandril, English shells alone may be used: all to be well slaked and prepared, and made into a strong composition of mortar, with clean sharp sand and water.

All the outside joints of the new piers and abutments, up to the springing of the ribs and the parapets, are to be well pointed with best Roman cement, and all other outside joints above these, and of the wing walls above ground, are to be well and neatly pointed with Scotch lime mortar, and all junctions with the old masonry are also to be well pointed, and made thoroughly good, and all deficient joints of the remaining parts of the old bridge are to be similarly pointed with cement and mortar, as above described.

The extended piers and abutments are to be well shoed or pitched with large rubble stones, not under 15 inches in depth, closely laid and packed with shivers and round gravel of the same breadth on the different sides, as at present, and those stones which have to be removed may be again used, and the remaining pitching of the bridge to be made completely good. The contractor must satisfy himself as to the nature and sufficiency of the foundations, as he and his sureties will be held responsible, and be bound for the stability of the bridge for three years after the completion of the same.

The contractor must turn two of the middle arches, or any other two which may be directed, on trussed centres, as no uprights or supports in these will be allowed to stand on the bed of the river, as they would tend to keep the salmon from getting through; and the covers of these centres must be close, to prevent the lime or mortar from falling down, and great care must be taken to give as little obstruction as possible to the salmon fishing.

It is also to be understood that the present bridge is to be kept open for the passage of carriages and the public, so long as it can possibly be done with safety, and without interrupting the necessary operations and convenience of the contractor.

The whole and every portion of the works hereinbefore specified, and as exhibited by the plan and sections and dimensions marked thereon, to which this refers, are to be executed in a most substantial and complete workmanlike manner, to the full and entire satisfaction of John Smith, architect, in Aberdeen, or any superintendent who may be appointed by the magistrates as resident inspector, or otherwise; and the new materials of every description used must be of the best quality of their respective kinds, and with the old stone materials to be subject to the approval or rejection of the superintendent; and should there be any dispute with the contractor, or any person in his employment, either as to the execution of the work, quality of materials or construction, or meaning of any clause in the specification or otherwise, as regards the works or plans referred to, the same shall be submitted to the said John Smith, whose decision shall be binding on all parties.

In case of the work being increased or diminished by any alteration which the employers may deem it advisable to make, which it shall be in their power to do at any time during the progress of the work, on giving timeous notice to the contractor, any addition or diminution of expense which may thus arise shall be paid to or deducted from the contractor, as the case may be, and the value ascertained at the time by the architect or superintendent, according to the fixed rate of prices which is to be given in by the contractor for that purpose.

The contractor is not to be allowed to transfer or sublet this contract to any other person, and he must at all times be at the work, or have a competent overseer there, to receive and execute the orders of the superintendent or architect; and such orders or instructions as shall be given to the said overseer shall be equally binding as those given to the contractor himself.

Sealed tenders are to be delivered, stating a slump sum for completely finishing the whole of the works, according to the foregoing specification, and plan and drawings to which it refers, with the exception of the alteration on the present east parapet of the bridge, the new foot-pavement, channel, and water pipes along that side, the pointing and making good the joints of the remaining parts of the old bridge, and making good the pitching of the foundations of the same, for all of which a separate sum is to be stated in the estimate; also detailed prices for the different descriptions of work for specification, as in the following schedule, and in the order of the same :—

Bearing piles, per cube foot.
Driving do. into the ground, per lineal foot driven.
Main piles, per cube foot.
Driving do. per lineal foot, do.
Sheeting piles, per cubic foot.
Driving do. per lineal foot do.
Wale pieces, per cubic foot, including fixing.
Sills, per cubic foot, including spikes and fixing.
Planking foundations, per superficial foot, including labour and nails.
Digging foundations of piers and abutments, including dam and pumping water, per cubic foot.
Digging foundations of wing walls, per cubic yard.
Outside ashlar work in foundations of piers and abutments.
Ditto, per standard rod of 2 feet in thickness.
Hearting and backing of do. per cubic yard.
Outside rubble work in foundations, per standard rod of two feet in thickness.
Hearting or backing of the same, per cube yard.
Covering of spandril walls, including all materials, and setting, per square yard superficial.
Malleable iron work, per pound.
Cast iron shoes for bearing and main piles, per piece.
Difference between furnishing and placing a common framed centre, and a trussed one as stated.

REFERENCE TO THE PLATE.

Fig. 1.—Elevation of the centre arch.—R. one of the ribs of liver freestone, of which there are five in each arch of the present bridge.

Fig. 2.—Plan of the foundation for two of the piers.—C.C. centre line of

* Lord Elgin's works are in Fifeshire, on the banks of the Firth of Forth, near Queensferry.—Ed.

present bridge.—P.P.P. present parapet on west side.—N.P. new parapet. In one of these piers are shrown the bearing piles; also the main piles, sheeting piles, and waling round the extended foundation. In the other pier are shown the sills resting on the bearing piles, the diagonal planking, and the top planking.

Fig. 3.—General plan of half the bridge.—P.P. present parapet.—N.P. new parapet. The shaded parts show the extended masonry of the piles and northern abutments.

Fig. 4.—Longitudinal section through one of the piers.—R. one of the ribs of freestone, on which rest the granite stones of the arch.

Fig. 5.—Transverse section through one of the arches.—R.R., &c., the freestone ribs.—S. the sheet piling.—M. the main piles.—B. the bearing piles.—And W. the waling.

The following is the detailed estimate of the contractor to whom the bridge was originally let; but who, from ill health, was obliged, with the concurrence of the provost and magistrates, to abandon the work before entering into the contract.

TIMBER WORK.	feet	£ s. d.
Bearing piles in piers	522.0	
Bearing piles in abutments . . .	104.0	
Sills in piers	164.0	
Sills in abutments	26.0	
3in. planks laid obliquely	399.0	
Another tier of 3in. planks over the oblique and across the present planking . .	520.6	
Oblique planking to cover the sills in the abutments	391.0	
Close planking on do., as for piers . . .	391.0	
Main piles for piers	320.0	
Do., do. for abutment	66.	
Waling under top of main piles . . .	391.	
Waling round the abutments . . .	77.	
Sheeting piles round piers and abutments	1459.8	
	4831.0	
At 2*s.* 6*d.* . .		£603 17 6

Detail of prices for timber-work.

Timber delivered for	1*s.*
Workmanship . .	6*d.*
Pile driving and casualties	6*d.*
Hoops, bolts, shoes, &c.	6*d.*
	2*s.* 6*d.* per cubic foot.

Timber for coffer-dam for piers (3 required.)

Guide piles	180.0	
Top waling	48.6	
Bottom waling	48.6	
Sheeting piles	607.6	
	884.6	
	3	
Allow this furnishing enough for two .	2653.6	
At 3*s.* . . .		398 0 6

Coffer-dam for abutments (1 required.)

Guide piles	75.0	
Top waling	20.0	
Carry forward	95.0	£1001 18 0

Brought forward	95.0	£1001 18 0
Bottom waling	20.0	
Sheeting piles	255.6	
	370.6	
At 3*s.*		55 11 6
Three sets of centres, 4 ribs in each, 12 ribs at £30 per rib		360 0 0
Covering boards, wedges, fixing, &c., at £10 per rib		120 0 0
Packing with hard rubble between the sheeting and bearing piles round the abutment	520.0	
Round the piers	2524.6	
Similar packing between piles, and under planking under the abutments	387.0	
Piers	7560.0	
	27) 10991.6	
at 8*s.* per yard .	407.	162 16 0

Detail of price for rubble packing.

Stone delivered for	4*s.*
Building . . .	2*s.*
Bringing into work	1*s.*
Lime, sand, &c.	1*s.*
	8*s.* per cubic yard.

Pitching with picked rubble round the abutment . . .	1125. ft	
Piers	4725.	
	27) 5850.	
at 9*s.* per yard .	217.	97 13 0

Detail.

Stone delivered for 6*s.*	
Do. got to work	1*s.*
Building	2*s.*
	9*s.* per yard.

Pulling down face work (ashlar) in abutments	1651.0	
In piers	1764.0	
In front of backing of arches . .	3210.0	
In wing-walls . . .	3680.0	
Remaining in abutments . .	688.0	
Below parapet wall	5508.0	
	16501.0 at ½*d.*	34 7 6
Rebuilding 4-5ths of the above . .	13201. at 4*d.*	220 0 4

Detail of price for re-building.

Laying by, dressing, and sorting	2*d.*
Conveying into work . .	½*d.*
Building with lime and sand .	1½*d.*
Per cubic foot, 4*d.*	

Carry forward	£2052 6 4

Brought forward		£2052	6	4
Furnishing new stones, and building in piers and abutments	5209.6			
In part of backing of arches	642.			
In wing-walls	736.			
Remaining in abutments	138.			
Below parapet wall	1101.			
	7826.6			
At 2s. 1d.		815	5	2½

Detail of price for stone-work.

Price in quarry	1s. 0d.
Carriage 2 miles	1d.
Dressing	9d.
Setting with lime	2d.
Contingencies	½d.
	2s. 1d. per cubic foot.

Hearting in the abutment	2690.4			
In the piers	9059.0			
	11749.4			
At 1s. 3½d.		758	16	3

Detail of price for hearting.

Delivering	1s. 0d.
Dressing	1½d.
Building with lime	2d.
	1s. 3½d.

RUBBLE WORK.

For backing of arches	18100			
In wing-walls	5520			
Remaining in abutment	688			
Below parapets	2754			
In spandril walls	2160			
	29222 at 5d.	608	15	10

Detail of price for rubble.

Rubble delivered for	2d.
Bringing into work	½d.
Building	1d.
Lime and sand	1½d.
Contingencies	½d.
	5d. per cubic foot.

4 counterforts, at £3 3s. each		12	12	0

Ribs of Freestone.

To be pulled down (front ribs)	1053, at 1d.	4	7	9
4-5ths to be rebuilt	842, at 8d.	28	1	4
Building with lime 6d. / Dressing and bringing into work 2d.	8d. per cubic foot.			
Building with new stones	24223, at 2s. 6d.	552	15	8

Detail.

Price in quarry	9d.			
Freightage	6d.			
Carry forward	1s. 3d.	£4833	0	4½
Brought forward	1s. 3d.	£4833	0	4
Shore-dues and cartage	4d.			
Dressing and polishing	3½d.			
Getting into work	½d.			
Setting	6d.			
Contingencies	1d.			
	2s. 6d. per cubic foot.			
Arch stones of granite	8778, at 2s. 4d.	1024	2	0

Detail.

In quarry	1s. 0d.
Cartage	1½d.
Dressing	8½d.
Setting	6d.
Contingencies	½d.
	2s. 4d. per cubic foot.

Flat stones . . 2833.4, at 2s. 4d. per foot	330	11	1
Filling semi-octagons with gravel, 6 at £1 each	6	0	0
Iron railing, including plinth, 40.0, at 8s. per foot	16	0	0
Filling in two turrets, at £3 12s. each	7	4	0
Cornice, including turret doors, 400, at 1s.	20	0	0
Parapet on west side.			
Pulling down 4800, at ½d.	10	0	0
Rebuilding 4-5ths, 3840, at 4d.	64	0	0
Building with new stones, 960, at 2s.	96	0	0
Cornice	10	0	0
Embanking approaches	200	0	0
Puddling over the arches, 89 yards, at 2s.	8	18	0
Paved channel, 1000, at 1s.	50	0	0
14 cast metal pipes between ribs, including grating and mouth-piece, at £2 10s.	35	0	0
Metaling carriage-way.			
7200, at 2d.	60	0	0
Deduct £42 10s.			
Contingencies	100	0	0
	£6870	15	5½
Deduct as above	42	10	0
Total estimate	£6828	5	5½

ON THE STRUCTURE AND PHYSICAL CHARACTER OF THE NORTH-WEST COAST OF IRELAND.

The sea-coasts of most maritime countries afford to the geologist a grand field of interesting phenomena, and furnish to him sections on a scale sufficiently large to show in all the detail of minute reality, the structure,constituents, aspects, organic remains, and those mineral treasures of its rocks, which in the interior of a country are so generally hidden by superficial accumulations of alluvium; and if the abrasion and erosion of the cliffs have been rapid, and their escarpments precipitous, their section will be in a great measure free from those chemical changes which so much alter the appearance of surface strata.

Probably no portion of sea-coast on the earth's surface more strongly exhibits the effects of this rapid destruction than that which we are considering. Exposed to the unceasing agitation of an extensive ocean, whose waves, moved by the general prevalency of westerly winds, have dashed for ages on its cliffs, after an uninterrupted roll of five or six thousand miles from the American shores, the effects of their impulsive energy is strikingly shown in the varied and fantastic forms which this coastline presents. Now where the waters of the ocean are so much disturbed, they hold in mechanical suspension particles of the abraded rock, which by their file-like action give a more effective power to its ceaseless motion; and the most prominent part of these rocks being of a siliceous character, are eminently fitted for this purpose. The prevalency of westerly winds as stated for the neighbourhood of Dublin is west, north-west, south, south-west, to east, south-east, and north-east as 9061 to 5141, and of 68 storms noted, 57 were from the south-west, and but 2 from the east and north-east; and there is no doubt that westerly winds are more prevalent on this coast than at Dublin. Let any one look for a moment at a map of the British Isles, and he will observe the rounded or flowing outline of all those parts which are sheltered from the Atlantic surge, while the coast exposed to its influence is deeply serrated or broken into detached masses: this fact is strikingly evident from the Land's End in Cornwall along the whole western coast of Ireland, to the northern extremity of the Shetland Isles. The portion of this coast which I propose to describe, extends from Ballysadere Bay on the east, to Clew Bay on the west. The general feature of the western half, is that of an overhanging perpendicular or rapidly sloping mountain mass, towards the west, south-west, and north-west; while the eastern or inland, slopes from one to five or six miles from a very general height of 1000 feet up to 2192, the highest part of the coast near Saddle-head in Achill Island. The smaller islands present the same features on a diminished scale, and the whole district has the appearance of having been tilted up on a line parallel to its own coast as an axis, while at the same time there is no doubt that many of the mountain masses, now eroded to their very centres, were once symmetrical about the present coast-line. What may have been the rate of waste per century cannot be ascertained by the observation of a few days, nor do any records supply us with these data, much less with the variable increments of waste for the different strata, their position, and the changes of meteoric influences to which they may have been exposed. As a general feature, the eastern half presents nothing remarkable. We infer then, that the general outline of this coast is the result of those physical powers which are still in operation. On the south-east of this district, a remarkable feature presents itself in the mountain of Keishcorran, its western escarpment being perforated by 10 or 15 caves, which extend under the mountain from about 50 to 10(feet; they are from 3 up to 30 or 40 feet wide at the entrance. The foot of the mountain rises steeply from a road at its base, which is 359 feet above the sea level, and this is also about the general level of the country westward: at the top of the slope the mountain rises perpendicular about 50 feet, and in this perpendicular face the caves are situated. Their floors are all on one level, and about 650 feet above the sea; the highest part of the mountain is 1183 feet above the same level. No one can compare the present sea coast with the escarpment of this mountain, without being struck with the identity of causes now in operation excavating similar caves at its low-water line. The undoubted inference is, that these caves formed the low-water line of the ocean, probably for some thousands of years, and that the adjacent country was then submerged about 300 feet below the level of the sea. These caves are in the carboniferous limestone. About 50 miles southward, in the neighbourhood of Galway, the syenite occupying the country westward is scattered in large masses over the limestone to the eastward for five or six miles: many blocks of from ten to fifty tons are thus translated, while on the other hand there are no erratic blocks of limestone to be found on the syenite westward. Combining this fact with the phenomena of the caves on the west side of the mountain, I infer that the sea had rushed over the present surface of the district under consideration, moved by the same causes which now impel it so powerfully on the present western shores. The mountain range which may be considered as forming the basis of this district, commences at Achill head, and is continued through Laughtdauhybaun, Nephin, and the Ox mountain, running nearly east. The river Moy passes through a depression in this range, which appears to have been excavated by the waters of the ocean rushing through the depression of Clew Bay isolating Nephin, and excavating Lough Con, the Moy, and Killala Bay. During this time it is probable that the range was gradually elevated from the bosom of the ocean, on the depression or basins of the river Shannon, as an axis, for the strata dip south-east, at an angle of about 20°. These basins are the Loughs Allen, Arrow, Key, and Gill.

Having considered this district generally, I will now proceed to examine it more particularly. And in point of situation, Achill Island first claims notice. Its form is that of the capital L inverted. One leg extends west twelve miles, with a general breadth of two and a half, and the other leg extending south is about eleven miles long, by a general breadth of about four miles. The meridian of 10° west from Greenwich intersects the 54th parallel of latitude on its north-western extremity. The portion which extends north and south, is separated from that which extends east and west, by a low valley perpendicular to the latter. The width of this valley at the southern end is about a mile, where it is bounded by a beautiful strand, upon which the sea throws great quantities of sea weeds, which furnish abundant manure for all the cultivated land in the island; portions of wrecked vessels from different parts of the Atlantic are also often stranded here. The northern end of this valley is comparatively narrow, and higher than the other, but it forms the harbour of the protestant colony. The soil of this valley is a dark sandy loam, and when cultivated with any skill, is tolerably productive of oats and potatoes, but the average temperature of the summer is much too low for the cultivation of wheat. This valley is well sheltered from the prevailing winds, and furnishes nearly the whole of the islanders with subsistence.

Commencing our tour of the western section of the island at the southern end of the valley, we traverse the rapidly sloping side of Slevemore at an elevation of about 600 to 800 feet of perpendicular cliff. At about four miles from the valley, we descend rapidly into a narrow defile, separating Slevemore from Croughaun mountain, filled with loose masses of rock embedded in a reddish ferruginous loam. This defile has become celebrated from its containing amethysts, locally known as Achill diamonds; but being full of fractures, they are of little use except as chimney ornaments. They occur embedded among the broken fragments of rock before spoken of, and fixed on a base of grey quartz and of various sizes. They appear to have been formed on the sides of some fissure on the

side of the mountain which has been disrupted, and its constituent matter tumbled into the defile. Continuing our progress westward, we ascend the rather precipitous side of Croughaun mountain, and attain an elevation of 2192 feet immediately above the sea. Here we cannot fail to be struck with the massive, sterile grandeur which presents itself, the mountain rising precipitously from the water's edge to a height of 2192 feet, extending about two miles westward, and terminating in a high precipitous ridge, near to which is an isolated rock called the Priest, to which superstition has ascribed some of the sacred functions of this character. The expanse of ocean, apparently unlimited, which extends westward, and the sombre gloom of the heath-clad mountains which the eye rests on in all the extent of land view, with the gigantic mountain features, conspire to impress in a high degree the idea of vastness and sublimity. The base of the mountain appears to have been eroded by the watery action, until the cohesive power of the rock was unable to support its enormous load, or perhaps assisted by some convulsion of nature, has shaken off its northern half. Eastward, Saddle Head rises into two humps, which are perfectly characterised by the name. From this point the coast is less exposed, and the mass of Slevemore is more central, but attains the height of 2204 feet, sloping rapidly to each side of the island, and towards the central valley. The remaining part of the north shore is formed by a cliff of 100 or 200 feet high, and the eastern is quite low and covered by shingle. At the south-eastern extremity the cliffs commence, and rise gradually to Duega, where they attain an elevation of about 1000 feet; they continue thus to the central valley, where they terminate abruptly. Near to Duega, this section of the island rises to an elevation of 1530 feet, forming a range extending northward, which slopes rapidly to the central valley, but gradually in all other directions. This island contains 35,283 acres, of which probably not more than 500 are cultivated, and this very imperfectly, although far the greater part of the island is capable of profitable cultivation. The soil is bog or peat earth, reposing generally on a subsoil of ferruginous clay.

The great constituent mass of this island is mica schist: in its general character it approaches very much to micaceous sandstone, and were it not for the presence of continuous seams of mica, the illusion would be complete. In the low and eastern part of the island it may be described as forming nearly vertical thin beds; the seams, formed of dark-coloured mica, run nearly east and west; this is particularly the case where the road comes down to the Sound. As we advance toward the higher parts of the island, the beds become more massive, and we almost fail to distinguish either the direction of the seams or the dip of the strata; and it approaches more to a massive micaceous sandstone, and in the western part of the island it passes occasionally into a conglomerate. As a building stone it is of little value, although a tower of some antiquity on the east side of the island has stood the storms for three or four centuries, but is now a ruin. As a foundation for roads it answers well, and is much used as a top-covering, but is quite worthless for such a purpose. About two miles of the extreme west of the island consist of quartz rock, well adapted for roads, and if used, would be exceedingly durable; while the other parts of the island have been removed by watery agency, this has stood as a barrier for some thousands of years. On the north shore, a quarter of mile east from the central valley, a flesh-coloured variegated primitive limestone occurs, embedded in the schist forming the cliff; but as to depth or extent nothing can be stated, for it is partly inaccessible. There is certainly sufficient for all useful purposes; and as none occurs within about 30 miles of it, its value is much increased. The Rev. E. Nangle stated, that it forms an excellent mortar, and probably it would also polish; it is highly crystaline and moderately hard.

The island is separated from the main land by a narrow sound, partly dry at low water. This portion of the main land is a triangular peninsula, caled Corraun Achill, and, with the island, constitutes the parish of Achill. It is bounded on the north by Bullaun Bay, a shallow creek opening into Black Sod Bay, by what is called the Bull's Mouth. The base of this peninsula rests on the sound about five miles; its length or height is about seven; the northern half and the western end of the other half are low. Corraun mountain occupies the southern half, and rises to a height of 1715 feet, sloping gradually to the south, east, and west, but rapidly to the north, and sending off several buttresses. Where these join the mountain, deep glens are formed, mostly occupied by loughs or lakes; and as the sides of these glens are covered with very black heath, they present a sombre aspect, and many of them have been christened by names to that effect, as the Black Plane, &c. Nearly the whole of this section is covered with a shallow stratum of bog or heath, reposing on a ferruginous clay. There are more than 200 acres cultivated, but much the greater part might be profitably taken in hand. The constituent rocks are mica schist. From the east end of the peninsula the shore continues low, and the carboniferous limestone commences skirting Clew Bay. This bay contains about 200 small islands, composed of the same rock. It is generally the case along the whole west of Ireland, that the projecting head-lands are of primitive rocks, while the bottoms of the bays are of the carboniferous limestone. The section north of the peninsula to the Owenmore river is bounded by Tullaghan Bay, on the north-west, a shallow creek with low shores, which continue low along Bullaun Bay, and consist of gneiss resting upon quartz rock in Knocklettercuss, which rises to an elevation of 1208 feet. East of this occurs a constellation of white-capped summits, the highestof which is Laughtdauhybaun, 2369 feet in height, a long ridge running nearly north and south, and sloping precipitously east and west. These heights consist principally of mica schist, supporting flanks of old red sandstone, and this again the carboniferous limestone on the east. This group gradually lowers in height as it approaches the limestone field, which commences near the boundary line of Erris.

The Owenmore, as its name imports, is the largest river in this neighbourhood; it is about 80 feet wide, having a current of water about half a foot deep, flowing about four miles per hour. East of this section occur two other mountains constituted of quartz rock, flanked by mica schist, upon which the carboniferous limestone reposes. One of these, called Nephin, the largest in this district, rises from the banks of Lougheon, 33 feet above the sea, to a height of 2640 feet.

Rising as this does, from a very low situation rapidly, it forms the most noble feature in the landscape. The variety and extent of scenery placed around it, is rarely equalled. To the north-east the cultivated portion of the country is divided into small fields by stone fences, and when the crops become partly brown in autumn, the valley of the Moy presents the appearance of a variegated carpet, which contrasts beautifully with the green tint of the ocean, the dark hue of the bogs, and the lighter surface of the numerous lakes.

The northern side of the mountain is traversed by a remarkable ravine; along its bottom a stream flows, and its sides are furrowed by numerous white bars joining the central stream, the dark heath of these parts having been removed by torrents during storms. These together present the appearance of a skeleton of some monstrous animal; the stream appears as the vertebral column, and the arched bands the ribs: this is no effect of fancy; it is the result of form, light, and shade.

The Mullet next presents itself for consideration: its shape is like that of Achill Island; its length is also about the same; but its breadth is much less. It contains 29,492 acres, about half of which are cultivated. It is a peninsula joined to the main land by an isthmus, on which stands the town of Belmullet. On the east is Blacksod Bay, a spacious and perfectly sheltered place, capable of containing in safety any number of ships of any tonnage that could be brought together. This bay was proposed as the terminus of a railway from Dublin, in connection with a line of steam navigation to America, and it is well adapted for such a purpose. Broad Haven, which bounds the Mullet on the opposite side of the isthmus, is a shallow creek. The Mullet is sheltered on the west from the Atlantic by a number of granite islands. Yarmon Hill on the south end rises to an elevation of 342 feet, and is composed of granite, which is quarried at the south-eastern point. It has been little used, and that only very lately, so that there are no certain means of estimating its durability; but from every appearance I think it would be great. It is imperfectly stratified, the felspar is a dull red and the quartz of a red gray, the mica black as usual. Northward it is flanked by gneiss, and this again by mica schist. The north shore consists of quartz rock, flanked by gneiss, upon which the last-mentioned schist rests. A loam of great fertility covers the north part, and also a portion nearer the isthmus. The centre is covered by erratic sand hills; northward it rises gradually, forming cliffs about 300 feet high; this part is bleak and sterile. Bloomeries were also formerly worked on this side of the peninsula.

The part of Erris east of the Mullet and north of the Overmore, is bounded on the west by low shores, rising irregularly into a cluster of hills, which slope rapidly to Carrowmore Lough, which is 30 feet above the sea. The west side of this lough is bounded by quartz rock, which reposes upon schist, the schist extending west and south to the bays, except the point adjoining Tullaghan Bay, which is gneiss. Eastward the basin of Carrowmore Lough extends about a mile, rising rapidly in the mountain of Slevefiagh, to about 900 feet. This is a table mountain of considerable extent, entirely a morass; it rises steeply from the Owenmore, and also from Glenamoy; but slops gradually to the limestone plain eastward. The west side of this mountain is traversed by several deep ravines, in which its drainage waters flow. It is composed of mica schist, on the east side of which beds of old red sandstone, shale, and grit repose, and on this rests the limestone.

North and north-west from Slevefiagh the valley of Glenamoy sweeps round from the basin of Carrowmore Lough and Broad Haven, about five miles wide, up to the east side of Erris, and in low morass, except along the river, where a considerable extent of cultivated ground runs along its margin, and appears to belong to the mica schist. From Broadhaven the coast rises in perpendicular cliffs 410 feet, but falls rapidly at Portacloe, forming there a boat-harbour, from which again it rises as rapidly, to about 800 or 900 feet of perpendicular cliff, and continuing thus about five miles. A second ravine occurs at Parturlin, and is appropriated to the same purpose as the former depression. About a quarter of a mile from this, the cliffs attain their greatest elevation on this shore, nearly 1002 feet, from which they sink gradually to about 300 feet; but rising again to about 600, they form a projecting head. From this a mountain runs parallel to the shore, sloping rapidly towards it, but gradually to the interior, as the whole coast does from Broadhaven. These heights are all constituted of quartz rock, worn into the most rugged and fantastic forms, and displaced and contorted in a most remarkable manner by dykes.

Thus I have completed the survey of Erris without the Mullet, which contains 203,396 acres; and, making the best estimate in my power, I think not more 2000 are cultivated, although nine-tenths at least might be so. The exterior covering of the rocks is bog, reposing on the usual subsoil, a ferruginous clay; and generally the depth of bog is not great. It is truly surprising that this part of Ireland, possessing, as it does, such facilities for improvement and such sources of wealth, should have remained to the middle of the nineteenth century in its natural state, with its inhabitants, in point of social condition, only a few steps removed from the savage state, and they an integral part of the richest and most improved empire in the world. Rivers and bays stored with the most valuable fish, a ready communication with every part, the greatest facility for draining afforded by the slopes of the ground, with sea-weed and clay at hand for improving the soil,—constitute a few of the advantages which this district enjoys. One most ridiculous notion has stood much in the way of improvement: it has been held, and the opinion is still common, that families entail on themselves a disgrace, which is not wiped off in one or two generations—but on the other hand is seriously imputed in all quarrels as a family debasement—if they have ever sold any part of the produce of their farms except live stock. There is not a shrub or bush greater than heath in all this extent of country; but the whole district was formerly much wooded, for numerous trunks of oak and fir trees are buried in the bogs in a sound state, and also when the bog is removed, many stumps of trees are discovered still standing as they grew.

It is probable that this absence of trees is caused by a deficiency of carbonic acid gas in the atmosphere. The tannin which is present in the bogs, preserves the carbonaceous matter from decomposition, and the country being supplied by air which has passed over the Atlantic generally, and they, as it were, shaken together, this probably frees the lower strata of the air from its acid, and animals are too few to supply the deficiency. The remedy, it is obvious, is to burn the surface of all the bogs, and thus supply carbonic acid, which will cause the trees to grow as well as before the bogs were there.

The small portion of cultivated land in this district is generally along the margins of the brooks and rivers, and from the mountainous character of the country, these are subject to sudden floods, by which the crops are often swept away; seeing, therefore, the precarious nature of their subsistence, it is not surprising that great want and destitution sometimes occur amongst the inhabitants, and that their calls for assistance have been loud and sincere. There is not I believe a single plough in all the extent of country we have passed over, and but three mills, all moved by water: one is a fulling mill, one of the other two is unfit for use, and the remaining one was lately erected at the Protestant colony in Achill Island. They grind a few oats and barley by a sort of hand mill, which consists of two stones about two feet diameter, cut in the ordinary way, and placed horizontally on the top of a tub on two sticks; with a

stick passed through the upper one, they give it a rotatory motion, supplying grain with the hand, and as it is ground, it falls into the tub; most of the water-mills in the adjoining districts, and one which I met with in this, are of a singular and simple construction, and as they are probably the most ancient of their kind, I shall give a brief description. The ancient Brehom laws contain statutory enactments for the protection of mill-streams, and most likely the mills were of this sort. The water wheel, made in the same manner as an ordinary under-shot wheel, is placed horizontally, and its shaft passing through, the lower millstone is fixed to the upper one; a stream rushing through a tube against the boards on the circumference of the wheel gives it motion, and with it the mill stone; to give the stones distance, a wedge passes under one end of the step on which the lower end of the shaft stands, and raises the wheel and stone together. This and the adjoining district contain about half a million of uncultivated acres, and it cannot fail to afford deep regret to the philanthropist, that some of the starving members of the human family are not employed to cultivate it for subsistence.

Proceeding now with our physical descriptions, a mountain rises in a ridge-like mass about a mile from the sea, on the bounds of Erris, but sinks rapidly into a valley at Belderig, where the schist comes down to the sea, but gradually rises into cliffs of moderate elevation, and consisting of quartzy rock, for about five miles, extending for about that distance inland, forming Benmore 1155 feet, and Maumakeogh 1243: this is flanked by shale and grit, which extends nearly to Killalla bay, forming rather low cliffs. This is remarkable for the symmetrical manner in which its cracks extend, these being defined with all the regularity of joints in a pavement; in some instances it is of little value for any purpose. From the borders of this formation, south to near Nephin, and west to Erris, extends the carboniferous limestone, in a low and level plain covered by bogs, forming a morass, and full of ponds of the most fantastic forms, its drainage being obstructed by other less permeable rocks on three sides. About four miles north of Killalla, occurs a small field of trachite, which is also seen on the opposite side of the bay: these are doubtless parts of the same field, which once extended across the present bay. To the geologist, this is of great value, as it is said to occur in no other part of the British Isles. From the embouchure of the Moy, extending about five miles westward, close to Killalla, and about one mile wide, a belt of carboniferous limestone occurs: it is of an oolitic character, of dark grey colour, and consists of grains of silver coated with concentric coverings of carbonate of lime, which are cemented together by the same substance: the beds are distinctly stratified, and of a useful thickness, dipping south-east at an angle of about 20°. As a building stone, this is most invaluable: Moyne Abbey, contiguous to this rock, was built of it in the beginning of the fourteenth century, by William de Burgho; its durability is proved by the stones still showing the most delicate touches of the chisel, and being in all respects perfectly sound. The Roman Catholic cathedral at Berlina, lately built, is also of this stone: it has been stated to consist entirely of carbonate of lime, but on dissolving several single granules this day, in dilute chloric acid, each granule deposited a grain of white silex. A little north of the middle of this rock, is an isolated mass of sandstone of a valuable character; it is eminently a freestone, and perfectly free from iron, which is generally so destructive to sandstones. The new bridge over the Moy at Berlina was lately built of it, and will probably be very durable. The basin of the Moy, extending about four miles eastward, and six westward, consists of the ordinary carboniferous limestone, with the exceptions just noted, and is nearly all under tolerable cultivation. The river is about 200 feet wide at Berlina, and navigable to within one mile from the town for ships of 200 to 300 tons burden. The mouth is obstructed by a bar of sand, on which there is about 4 feet water at low tide; the tide rises from 9 to 15 feet; the salmon fishery of this river lets for £1500 a year. The entrance to Killalla is much the same as that of the Moy, in relation to depth of water: the intervening space is mostly sand and sand hills, dry at low water. I have now come to the last [section which I propose to notice: it is occupied chiefly by the Ox mountain, which sweeps round from Ballysadere bay to the valley of the Moy, forming a triangular mass, the north and west sides of which are about 16 miles long, and the south-east 22 miles. Its general height is about 1000 to 1200 feet, but rises near the east termination to 1778 feet, and this height] consists of hornblende slate. The remaining portion consists of granite, quartzy rock, and mica schist, upon the north side of which rests a belt of old red sandstone. The north side slopes gradually towards the sea; the south side is precipitous in the opposite direction. Lough Fall has an elevation of 455 feet, in the immediate vicinity of which the mountains rise to 1446 feet. The remaining portion of the north shore consists of carboniferous limestone, with the exception of the trachite before noted, and a portion of shale and grit, forming a part of the coast for about five miles, which commences about four miles east from Esky: nearly the whole of this shore is a low cliff of 100 or 200 feet. The cultivated ground of this section is nearly co-extensive with the limestone, forming a belt along the coast of from two to four miles wide. It is surprising that more progress has not been made in reclaiming the mountain, seeing the abundance of limestone, turf fuel, and clay on the very spot required.

The whole of this carboniferous limestone field contains abundance of organic remains; for considerable spaces they constitute almost the entire rock: in the shales, schist, and sandstone, I observed none, but I believe some few have been noticed. It is interesting to inquire into the causes from which arises this abundance in the one case, and paucity in the other. The bed of Esky River and the whole of the neighbouring rocks are particularly rich in organic forms, mostly low in the scale of organization. Struck with these relics of a distant age, and the undoubtedly different conditions which must have existed during their accumulation, I cannot avoid here a few general remarks. Some other members of the carboniferous group are remarkable for the vast amount of vegetable matter contained in them; but the paucity of air-breathing animals in this and the preceding strata would seem to countenance the supposition, that the conditions required by their organization were not in existence, while those which vegetable life require were greatly developed. It would also appear that the conditions required by water-breathing animals were also very favourable but that these conditions were suddenly changed, at least for limited portions of the ocean, probably by being furnished with hydrate of lime from some internal source, which, uniting with the carbonic acid of the atmosphere, rendered the waters of these portions of the ocean unfit to support the life of its branchieferous inhabitants, and they were thus precipitated together. They afford evidence in their perfect forms of having died and been buried in the same time and place. It is a highly probable supposition that the ancient atmosphere was of much more extensive dimensions than the present, and was constituted more largely of carbonic acid gas,

from which a portion of the rocks bearing the marks of chemical precipitation have been derived. It is quite evident that the temperature of these regions was much higher than the present, and this would be the result of an enlargement of its volume. But if the amount of carbonic gas were much increased, it would be unfit to support the life of air-breathing animals, a condition which appears to have existed previous to and during the carboniferous era. Humboldt found on the table mountains of South America that for the ascent of every 187 metres the centigrade thermometer fell one degree; therefore, if the earth's atmosphere were as much increased in density at the earth's surface as it is decreased in the ascent of each 187 metres, its temperature would be as much increased. It might be supposed that the distance from the earth's general surface was the cause of the change of temperature observed by Humboldt; but when we consider that in any state of matter, whether gaseous or solid, each particle retains and transmits heat as the density is increased, this effect must follow in proportion to any increase of density in the earth's atmosphere.

And further, it is a well-known fact that chemical combinations do not take place from solid masses, but from fluids or gaseous states of the constituents combined. Therefore these constituents must have existed in such a state previous to their union in the carboniferous strata: and they could not have so existed in the water of the ocean, for this would have made it totally unfit to support that host of organised forms whose skeletons now form so large a portion of the strata we are considering.

Admitting that the carboniferous limestone has been separated from the waters of the ocean by the vital functions of its water-breathing inhabitants, or that it constituted their bodies which have been consolidated into this rock, or that it was precipitated from chemical combination with hydrate of lime, the question is still the same. From the waters of the ocean it has been deposited, but in these waters so vast a quantity of carbonic gas could not have permanently existed; for it appears to constitute about one-fortieth part of this formation. Now, if existing in the atmosphere, it would be in a fit state to be absorbed by the leaves of plants, or uniting with the soil would furnish that great constituent of all vegetable matter, carbon; the agriculturist knows well the value of soot and other carbonaceous manures in producing a luxuriant vegetation.

Add to this the increased density it would give to the atmosphere by its great weight, which, as we have seen, would increase its temperature, and these causes alone would, we think, produce a climate whose vegetation, even in Great Britain, would be more luxuriant than that of the banks of the Ganges or the tropics of southern America.

We have already observed that the paucity of organic remains in the underlying strata does not appear to indicate a state of atmosphere favourable to air-breathing animals, and it may be added that both these and the superior saliferous formations are equally destitute. It is with the oolitic period that terrestrial life begins to be more fully developed, when the constitution of the atmosphere became purified by the deposition of the carboniferous strata.

The intervening period of the saliferous formation appears to have furnished the preliminary conditions of their existence, such as soil and vegetable growth upon the ruins of the carboniferous era.

It should be observed that the oxygen set free from its union with carbon, forming, as we have supposed, carbonic acid in its gaseous state, would find its place in its union with the various bases of the earths whose oxides constitute so vast a portion of our rocks.

Having thus glanced at the causes of the paucity of terrestrial remains in the older rocks, the temperature of the carboniferous era, and consequent vegetable growth, it remains to consider briefly the destruction of aquatic life.

Not only the carboniferous, but the limestones of all periods are more richly stored than any other rocks with these remains. We cannot perfectly satisfy ourselves on this point, but as we have already intimated, it would appear to result from the formation of carbonate of lime in that fluid which they breathe.

Having already transgressed all reasonable bounds, in this most interesting speculative inquiry relating to the constitution of the ancient atmosphere of our planet, still, we cannot leave it without observing, that if the volume and mass of the atmosphere had been greatly different at any period, the ocean's level would also be altered.

The centrifugal force would be greater towards the equator, the pressure would be consequently less in proportion than at or towards the poles, and this would change the sea level. Also the violence of storms would have been increased to an extent sufficient to account in some degree for the vast accumulation of water-worn materials, constituting the mass of even the most ancient rocks. Currents of water would be generated to and from the equator, and, in fact, the whole relations on the surface of our globe would have altered with each of such changes in the volume of the atmosphere.

There is no end to speculation, return we then to our immediate subject:—

This formation of carboniferous limestone forms by far the greater part of Ireland. It is of a dark grey colour, generally highly crystalline, and where its surface is exposed, deeply furrowed, containing caves and fissures, particularly where its elevation is much above the sea level. Very few streams traverse its surface, as they find a course through its numerous interstices. The stone is much liable to lose its cohesive power, and being subject to rapid decomposition, is comparatively worthless as a building material, but as a mortar is of excellent quality. Numerous massive castles are built of this stone, but nearly all in ruins; in many instances cracks extend from top to bottom, passing through the centre of the stones, and not along the joints. The ascent to the floors of these buildings was generally formed by a flight of stone steps inserted into the wall and resting by their edges on each other, but generally they are broken off at the wall and fallen, the tops of the buildings exposed are rarely entire, but the mortar is strong and hard.

Several public works have been recently constructed of this stone, as a bridge over the river Ern, in the county of Cavan, docks at Galway, and we think the beautiful pier and works at Limerick, but its employment here we think far from judicious.

This stone being abundant, and always at hand, it appears cheap, but if its inferior durability be considered, the economy of using it is certainly doubtful.

It is only in favourable situations that a soil is formed on this rock. When higher lands and more compact formations are adjacent, the loose materials are carried upon the surface of the limestone, and filling up the interstices the stone becomes decomposed, and mixing with the siliceous earth forms a most excellent soil, and resting on a dry, warm, and porous rock, or subsoil, its fertility,

with proper cultivation, is very great. It is evident from what has been stated of the locality of the limestone of this belt, that it is exactly so situated. But in some patches where it is not so favourably circumstanced, the decomposed material is carried through its interstices, and the rock remains a barren, naked waste. It is well known that this formation is very extensively prevalent in Ireland, and the observations made on this belt will apply generally to the whole country.

This coast is traversed by several basaltic dykes, which for straightness of direction, uniformity of dimensions, parallelism, and length, are probably unequalled by any on the surface of the earth. They are composed of fine-grained, compact, heavy basalt, and are from 3 to 150 feet thick; they are nearly perpendicular where they pass through the cliffs, in some instances projecting with an even surface like a buttress from a wall; their direction is east-south-east. The strata through which they pass is much distorted, and the limestone rendered more crystalline where in contact with them. Having been observed by different persons at different points, lines were drawn through these points on an accurate map, and I verified their existence in several places, and found them to be exactly on the line drawn; some of them have also been verified to the east of the country included on the accompanying map. In many places they do not come to the surface, but are seen in the cliffs several feet from the surface, and in others they are covered with shingle or alluvium, and hidden from observation. This coast is frequented in abundance by most kinds of fish common to our seas. The fishery employs occasionally about 600 small open boats; a very few are half-decked, and many of them about Erris consist of a frame of wood covered with skins or tarred cloth. Many of the varied kinds of rocks spoken of being covered with bog, are necessarily very imperfectly defined in their extent, but this is unavoidable.

We have thus completed the survey of this district, comprising about 120 square miles, and about 200 miles of coast line. We have also occasionally noticed things that appear not to belong to the proper subject, but for this we hope to be pardoned, as they are illustrative of the social condition of a people who inhabit a country, like themselves, wild, unimproved, and natural.

W. G.

ON THE LEAD COUNTRY OF NORTHUMBERLAND, DURHAM, AND CUMBERLAND.

DR. MITCHELL'S REPORT TO THE CHILDREN'S EMPLOYMENT COMMISSIONERS.

This country, though politically distributed amongst three counties, is one and the same in all its characteristic features. From it flow the Tyne, the Wear, and the Tees, and many branches which fall into these rivers. Along the banks of these and of several smaller streams which fall into them, are dales or valleys, cultivated near the banks, and for a short distance up the sides of the hills; but soon cultivation and enclosures cease, and beyond them rise dark fells, covered with peat moss and heath; and between one vale and another is a wide extent of high moor-land, extending sometimes for a dozen of miles. In these upland tracts are no inhabited houses, but thousands of black-faced sheep are scattered over them; and there breed the grouse which attract the sportsman at the proper season of the year to the country.

The rivers do not, as in rich flat clayey lands, form for themselves a winding serpentine course; they flow right onward in a straight line and with a rapid current. The channel, of which the water occupies but a small portion in dry weather, is covered with boulders of some hundred-weight down to small pebbles, and here and there are accumulations of sand. After rain, and in winter, the stream flows in a powerful flood. Everywhere, at only short distances from each other, on both sides of the rivers are vales or gullets, with the banks feathered with wood, through which with thundering noise the smaller streams, here called burns, rush over the stones to join the great stream below. These deep fissures are of importance to the subject of our inquiries, as they often lay open to view the veins of ore, and direct the operations of the miner to places where it is met with in sufficient plenty to reward his toil.

As much of the fate of the miners will be found to depend on the romantic nature of the country, and the consequent attachment of the inhabitants, and the impossibility of bringing themselves to leave it for any other land, I shall enter into a more particular account of each several dale.

Weardale will be held by many to be the most beautiful of them all. It gradually contracts into narrower spaces, and the hills become loftier on proceeding westward from the low country. Strictly Weardale is a vale fifteen miles in length, and is considered as commencing about three miles below the village of Stanhope, and from where it commences up to that village, the grass lands are interspersed with fields of wheat, oats, and turnips; and for three miles higher up than Stanhope, occasionally corn land may be seen, and the soil is fertile and the crops abundant. Hitherto there is much woodland interspersed, but gradually, as we ascend, the patches of woodland are fewer and farther between; still for some miles there is a considerable show of trees by the river banks, and thick plantations on the sides of the ravines, through which over rocks and stones the burns dash downwards. But towards the upper part of the dale the trees are solitary, or in twos or threes near human habitations, or occasionally on the river side. At last is Wearshead, a hamlet where two burns meet, and first give a name to the Wear, and each rises a mile or two higher up to the centre of wild, treeless, heath-covered hollows in the mountain.

Both sides of the dale for three quarters of a mile back from the river at Wearshead, and still farther back lower down, presented in August last the most beautiful green, and a rich vegetation. The whole of the dale is well enclosed with stone fences, and is subdivided into holdings of about five acres each. Houses are accordingly distributed over it on both sides of the river, like a continuous scattered village. These houses are substantially built of blocks of stratified hard sandstone, and are covered with slate; and as lime is abundant, they are well white-washed, and present a clean neat appearance; the fronts are towards the sun. Here and there is a little hamlet by the wood side, the residence of tradesmen to whose stores and workshops the population of both sides of the vale resort. There is much travelling backwards and forwards along the road, but seldom does an inhabitant of the dale pass far beyond its bounds. On the Saturday were many carts, conducted by miners loaded with coal, for which they had gone to the nearest pit on the edge of the coal country. But for the week that I was in

this dale, I did not see so much as one coach and pair, and only two gigs, and these belonged to commercial men travelling on business.

The inhabitants of the dale see few but themselves, and of course intermarry together; so that in fact, by nearer and more remote relationship and affinity, they constitute but one great family.

Altogether the natives of the dale grow up with an attachment to their native land and their own people which nothing can overcome. Hence it is that, although by removing only twenty miles lower down into the coal country, a young man might nearly double his income, and have the prospect of adding many years of health and strength to his life, he cannot remove—he clings to his beloved dale, and follows an occupation which in most instances allows but a short life, the last years of which are spent in sickness or sorrow. And this too is the effect on a population well educated, and of intellectual capacity and acquirement surpassing any I have ever met with in England.

The river Tees rises in a hollow near the foot of Cross Fell, and is soon augmented by other mountain torrents. For many miles it flows through a desolate valley with a little grass land on each side, a few solitary houses with only now and then a solitary tree. Gradually the vale widens, and for three or four miles before coming down to Middleton in Teesdale is well adorned with wood. On the Yorkshire side, the rude hills approach very near the river, and in some places present to it lofty cliffs. Middleton-in-Teesdale is an exceedingly pleasant village, embosomed in trees, with the Tees flowing on its south side; and here the Yorkshire hills recede for several miles. Below Middleton, and down to Barnard Castle, Teesdale is an exceedingly beautiful vale, and its grass lands are interspersed with fields of grain.

From Stanhope it is ten miles in a northerly direction to the mines and washing floors on the Derwent. At first is a turnpike road, then a road made by the parish of Stanhope, almost as good, then a road by the parish of Edmonbyers, which is continued by the parish of Hunstonworth, both portions as bad as a road can be made. The Fell is altogether uninhabited, and it may be stated, as a proof of the severity of the climate in winter, that there are high posts of wood painted white, and the top part black, to enable the traveller to find his way during the snow. Such posts are usual on other fells in this country.

The vale of the Derwent, near the works of the Derwent Company, is not 100 yards wide, and the uncultivated land of the fells comes very near to the water. The miners and washers come from a distance, and lodge in the lodging shops provided for their use.

The upper part of West Allendale, and of East Allendale, where the mines and washing floors are situate, are very wild narrow vales, inclosed within lofty dark fells.

From Weardale to Alston Moor, the road lies over a high uncultivated dreary tract, which at last conducts to the busy village of Neuthead, with its smelting mills and its washing-floor, on which may usually be seen a multitude of children engaged at work.

The little river Neut flows five miles to the town of Alston Moor, through a narrow vale of beautiful green grass, divided into small buildings, and studded with white houses like Weardale, but with very little wood.

The town of Alston is agreeably situate on the side of a hill close to the river Tyne: it is beautifully surrounded by wood. The vale of the Tyne below the town, is richly cultivated. This vale ascends for about five miles between lofty hills, to where the river rises in a hollow at the foot of Cross Fell, which lofty mountains on the south, with other mountains on the west, give an interesting grandeur to the prospect from every place in the vicinity of Alston.

The whole of the lead country possesses great beauty, though of diversified character; and it is no wonder that it rivets the attachment of the natives. They think of no other world but this little world of their own, and mining is their sole resource. To this attachment to the country, and to each other, we may attribute their continuing to engage in an employment which ill remunerates their toil, and brings many of them to an untimely grave.

The lead country, in a geological sense, is below the coal measures, and above the old red sandstone. The lead measures consist of many strata of siliceous sandstone, limestone, and clay shale, with beds of indurated clay between them. The lead is found in all these strata, though not often in clay or in clay shale; and a vein will descend from the surface down through all these strata, until it is so deep that it can no longer be followed on account of water, and other physical difficulties. Amongst the most remarkable beds is the encrinital limestone, with abundance of its peculiar fossil remains. It may be seen in the bottom of a large burn which falls into the Wear some miles below Stanhope, near Frosterly Bridge, at a place called Bishop's Crag. Limestone-boulders gathered from the bed of the Wear, supply the limekilns; and there are limestone quarries now worked about two miles below Stanhope, and also near the commencement of the Stanhope railway. Near the same place are beds of ironstone of excellent quality, which are expected to be worked, and carried by the railway to furnaces in the coal country.

NATURE OF EMPLOYMENT.

There are three grand divisions of employment connected with the mines:—

I. The working of the mines.

II. The washing of the lead ore.

III. The smelting mills.

Of each of these divisions it is now attempted to give a description.

Of Working the Mines.

Entrance into the mines is almost always by a level driven into the sides of the hills. In former times shafts were frequently sunk from the top, but that is seldom the case now. The level is made about six feet high, sometimes seven feet high, and from three to four feet wide; and, where necessary, it is arched with stones. A railway for the waggons is laid at the bottom. By means of this level a great deal of water may be brought out of the mine; the carts may be drawn in by the horses to a certain distance; the ore may be brought out; and the miners may walk in to their work, or at least to places where they ascend or descend. The level is usually driven into the hill as far as possible, in the stratum called plate, being clay shale, if such there be; that stratum being softer and more economically worked than any other.

The object in view in penetrating through the hill by means of a level, is to arrive at a vein of ore; and when the working can be got on the first level, it is most advantageous to all parties. In the level of the mine at Stanhope Burn, which I visited, after going nearly half a mile forward, there were several chambers, in which the men were at work, breaking down the lead ore by hammers and picks, drilling holes, charging with gunpowder, and firing

off shots. It was stated to me, that the level extended through the vein of limestone rock with lead in it, as much as 100 fathoms, and I saw no reason to doubt it.

I now describe the work, first observing, that the tools used by the miners are few and simple :—

1st. The jumper.—This is an iron chisel, pointed with steel. The usual length is eighteen inches, and sometimes two feet. One miner holds it against the rock, and another miner or boy strikes the end with a hammer. From time to time the dust has to be taken out of the hole.

2nd. The hammer.—This is used for striking the end of the jumper.

3rd. The pricker.—After the cartridge is put into the hole, the pricker, which is a thin rod of iron, and the outside end formed into a ring, is driven into the hole, and through the cartridge. It is usually made of iron, which may cause sparks, when the boring takes place in siliceous rock, or even in limestone; for frequently the limestone elicits sparks, as I have myself seen it do, both from the hammer and the spade, probably from the siliceous matter mixed up with it.

A copper pointed pricker would obviate this risk.

4th. The driver.—This is a piece of iron with a broad head, which is used to drive the shale down along the side of the pricker. The head ought to be of copper, but it is seldom so.

5th. The scraper.—This is used for taking out the dust from the hole which has been made by the jumper and hammer.

In breaking down the rock, the lead miners use a pick, very like that employed in the coal mines, also a great hammer.

The first thing is to drill a hole in the rock with the jumper and hammer. The miners then insert a cartridge of gunpowder, and this they do in the same way as if charging a gun with a cartridge, so that it is the same whether the hole has been bored perpendicularly, horizontally, downwards, or sidewards. Boys and young persons may drill the hole, but they are seldom trusted to charge with the powder. The next thing is to take a pricker, and insert it in the hole, and drive it through the cartridge, and keep it there for a time: then they take what they call plate, which is pieces of black shale, and put it in at the sides of the pricker, and with a driver, which has just been described, they force the plate down as far as it will go, and keep on at this work until they have filled up the whole of the hole round the pricker. Then the pricker is drawn out by inserting the scraper in the ring at the end, and which leaves a hole open down to the powder. The men thrust down this hole a squib, and they make a match, and one man puts it on the end of the squib. All the people, except this man, run away, and get into the level, or some place where the stone directly coming from the explosion cannot hit them, and they turn their backs for fear of any piece being reflected back into their faces. The man who has to fire off, then lights the match, and runs off as fast as he can, and presently the shot goes off with much noise, smoke, and dust. The men return, and find a chasm made in the rock, and with hammers and picks they strike upon every projecting piece of rock, and bring it down. The chamber where they work is now full of smoke, and every additional shot fired off makes the place worse and worse, as they continue their work throughout the day. When the rock is wet, the patent fuse, being a slow match inside a rope, is found convenient.

When the miners have cut out the ore which is near the level, the level is arched over, and they proceed working upwards. The deads, or rubbish, that is, the rock not containing ore, is let down behind them, and they keep ascending. Different sets of men will be working in places above each other, and they are protected by scaffolding. When the one is to be removed, it is let down a channel made for it, through an opening called a hopper, into the cart or waggon in the level.

In some mines there is much work in the first level which is driven, but frequently it is necessary to ascend upwards, and make another level, and this is effected by drilling and blasting out the rock by gunpowder, and placing scaffolding by which the miners may climb up to their work. It is easier to work upwards than to work downwards, because, in working upwards, all the dust and broken pieces fall down, whereas, in working downwards, they accumulate at the bottom, and it is troublesome to remove them. The miners in their upward work make a small landing-place, and go from one stage to another, so that they may be able to place ladders or piers of wood from side to side, and be afterwards able to climb up, and have halting places at short distances all the way. When arrived at the height thought best to fall in with the veins, they move forward horizontally, or in a line parallel to the preceding two, and it may be several times repeated.

In like manner it may be expedient to follow the vein downwards by sinking, from one stage to another, an opening for ladders or flights of steps, to go down, perhaps, 18 or 20 fathoms, or 108 to 120 feet. Then they may run an opening forward horizontally, or parallel to the first level, and after a time they may have to descend again, as much as before, and then move forward, and so on several times, perhaps four, five, or six times, until the place of working may be 500 or 600 feet lower down than the first level.

(To be continued.)

POST OFFICE COMMUNICATION WITH IRELAND.

CASE OF CHEPSTOW, NEWPORT, CARDIFF, AND THE OTHER SEA-PORTS OF THE BRISTOL CHANNEL.

There are some circumstances in the decline of empires and states which find a corresponding analogy in the most limited localities and the most insignificant interests. The jealous rivalry and deadly feuds of faction, the absorbing spirit of political intrigue, the withdrawal of a people from the pursuit of useful enterprize and solid industrious occupation, to waste their time and faculties in frivolity and luxury, or in any other fruits of idleness, may all be seen in as active operation in many a provincial town as they ever were in any great empire before its decline and overthrow. There are many towns in England which were once the seats of extensive manufactures—many a stately fortune has been amassed within their walls; and not a few of the highest and noblest in the land may well look back with gratitude, if not with pride, upon the founder of their house, in the person of some provincial Rothschild, whose name still lives in the annals of the decayed town or the deserted village. The symptoms of waning prosperity, and the harbingers of fast-approaching decay, are often so obvious and so easy of observation, that even the monstrous folly, or the lamentable imbecility, of the inhabitants of such places is seldom proof against the growing conviction. They see the importance of their town gradually contracting into a narrower circle, its vested rights invaded, and one prerogative after another wrested from it; its

inhabitants madly abetting the spoliation, or yielding in sullen acquiescence, till the place which was once the thriving centre of a flourishing district, with its markets and fairs more celebrated than those of all the country round, with its court-house, and town-hall, and jail, and assizes, and privilege of sending two burgesses to represent it in parliament, being all, one by one, swept away—has become the deserted bye-town, far from the route of busy traffic, remembered only for what it has once been, and commanding no distinction for what it now possesses. To such an end as this too many a fair and goodly town is hastening with rapid strides, and it would well become such of its inhabitants as lay claim to any share of influence or spirit to oppose themselves with might and main to save the household homes of themselves and their neighbours from destruction. Much may be done by individual exertion, and much more may be done by the combined exertion of a few powerful individuals, and we trust that the application we are about to make of these remarks will have its weight in stirring up to exertion some of those whose present culpable apathy cannot be too highly reprobated. These remarks then have been called forth by the proposal which is now under consideration, for transferring the packet station for the south of Ireland from the port of Milford to Bristol, or to some port in the channel near the mouth of the Bristol river. The present route of post-office communication with the south of Ireland is by the Great Western Railway to Bristol, thence by common road to the Aust Ferry, where the Severn is crossed, sometimes in an open boat and sometimes in a steamer; from the opposite side of the river, through Chepstow, Newport, Cardiff, and Swansea, to Milford, and thence by mail packet to Cork and Waterford. Now, if the proposed arrangement be carried into effect, the whole of the land route beyond Bristol will be avoided, and hence a mighty outcry has arisen from the line of towns we have mentioned, namely, Chepstow, Newport, Cardiff, and Milford. The inhabitants of these, finding that the world is in movement in various directions around them, have awakened to the impression that it is time for them also to be stirring. And what resolutions, the reader will ask, have they come to under this prospect of suffering serious injury to their commerce, prosperity, and provincial importance: they have proposed doubtless to do every thing in their power to remove all objections to the present route, and have perhaps come forward handsomely, with funds to effect, or at least to investigate, improvements which might enable the present route still to command the preference which it has hitherto enjoyed.

The answer to all this is, that they neither have done, nor—as far as any one can see—do they intend to do, any thing of the kind. Not an idea in the world have they about setting themselves to work to improve any part of the present route; not one shilling in the world can they think of subscribing for the credit of their country, or even for the benefit of their own interests. Oh no! it is none of these things which they are doing, not a single exertion are they making to protect themselves; but, on the other hand, they have been for some weeks loudly and importunately calling upon Parliament to help them. Yes, in several of the appendixes to the 40 reports on public petitions, we observe the prayers of the gentry, clergy, bankers, merchants, and others of those towns, all in great alarm and consternation at the contemplated changes in the post office communication with Ireland. Now, is it possible they can imagine that Parliament will pay any attention to those petitions, for, is it not perfectly well known that before any such change is decided upon, Government would, whether petitioned or not, consider whether any grant of public money might, with expedience, be applied to improve an existing route, in preference to adopting a new one. But, although the Government may not choose to sacrifice public money to the object of placing an inland route in competition with steam-packet navigation; yet it might well happen, if other bodies, whose more direct interest it is to improve such inland route, were to do so in right earnest, that Government would then abandon any idea of changing the present route, and so the whole advantages at present enjoyed might be retained for a long time yet to come—for as long a time in fact as their possessors should continue to deserve them. These petitions, one and all, take it for granted that the present culpable state of the Aust Ferry, near Chepstow, is the reason which leads to the proposal for abandoning the existing route; and they modestly request that Government will be pleased to adopt measures for putting this ferry into an effective state, in order that this objection to the present route may no longer exist. Now, first, as to the state of this ferry, it is undoubtedly bad enough, inasmuch as on the Bristol side there is no such thing as a pier which vessels can approach, except at high water, so that ninety-nine time sout of a hundred, whenever the mail arrives at the Aust Ferry house, the whole of the passengers have to descend and to walk along a wet, muddy beach, under high dripping cliffs of lias clay, for nearly a quarter of a mile in length, and then a miserable little open boat awaits them, in which to cross over to the Chepstow side. Of course this boat is occasionally upset, the Severn being a very dangerous river, and the nature of the passage rendering it necessary to make several different tacks before reaching the other side. Many valuable lives have been lost by the upsetting of this miserable ferry-boat, among the most recent of whom is one of the Messrs. Crawshay of Cyfartha Castle. It is true there is an old worn-out steamer which occasionally plies between the two sides, but this is of course still more incapable than the small boat of floating at the side of the apology for a pier, so that, whether steamer or open boat be the order of the day, the muddy walk along the wet beach is invariably the fate of the luckless traveller. In consequence of the difficulty of this passage at night, the mail passengers and letters are detained in Bristol from a quarter past one in the morning till ten minutes before six, and it is this serious inconvenience which the petitioners call upon Government to remedy, by improving the Aust Ferry. Now we venture very confidently to predict that this is what Government will never do; but at the same time it is probable that, if the towns which are interested in the case chose to undertake this improvement, and so prevent the delay of nearly five hours at Bristol, the Government would then consent to continue the post office communication in its present route.

The modesty of the request which has been made to the Government on the subject has seldom been exceeded, except by that of some little borough in the North Highlands of Scotland, which not long since memorialized the President of the Board of Trade with a prayer, that his Lordship would be pleased to order a line of railway to be surveyed from Edinburgh to their borough aforesaid, because the borough itself was unable to defray the expense of such a survey. Who was afterwards to make the railway is not mentioned, at least the provost and baillies had not decided about whom they should ask to do this. It would be time enough to think about that when the survey was made. We need scarcely inform our readers whether or not his Lordship the President

acceded to the peculiarly disinterested wishes of these northern luminaries. The towns in the west allude to the improvements executed by Government in the route through North Wales as a precedent for similar assistance in South Wales. Such a plea does them little honour; for, while the one is an exceedingly poor and primitive country, entirely engaged in agricultural pursuits, the other is a busy and flourishing commercial district, abounding in mineral wealth, and the seat of the largest iron-works in the kingdom. There is no parallel between the two cases, and so the petitioners will find when it is too late.

We have considered what the petitioners themselves term the principal objection to the present route, namely, the state of the Aust Ferry; but it is entirely begging the question to suppose, that the improvement of that ferry is all that is required by the vast intercourse between Great Britain and the south of Ireland.

The inhabitants of the towns we have mentioned, and the wealthy and influential proprietors of the counties in which they are situate, have a heavier sin to answer for than that of allowing the Aust Ferry to remain for many years in its present dangerous and disgraceful state. When all the world has been in agitation around them to secure the benefits of railway communication, they have to show cause why the extension of the railways into the west of England has come to a dead stand-still at Gloucester. There was a line some years ago which made considerable stir in the world, and raised considerable expectations in this part of the country. This was the line across Monmouth, Gloucester, the Welsh counties, from the city of Gloucester to Fishguard harbour on the coast of Pembroke. This was undoubtedly a splendid line of communication, and one which would have greatly accelerated the trade with Ireland, America, the East and West Indies, and in fact with all parts of the world from which vessels trade with our western shores. The interests, however, which oppose this line, are probably too powerful to admit of its successful revival: it would have too deeply injured Bristol, Gloucester, and all the ports of the Bristol Channel, by concentrating a great mass of our foreign trade into a new port which was to arise at Fishguard, free from all the difficulties, dangers, and intricacies of a river navigation, to have been at all palatable to the commercial interests interwoven with the existing ports.

The heavy and rugged nature of the country was another objection to the Fishguard line; but this is of less consequence, since it is known that the locomotive engine is capable of working with advantage on planes of much steeper inclination than those which were at that time assigned as the maximum of steepness on railways.

There was another line proposed, however, through a district of country so favourable, that the gradients might have been of the very best description. This was the line from Gloucester along the north shore of the Severn and the Bristol Channel, through Chepstow, Newport, and Cardiff. Here would have been a direct competition with navigation by water, in which latter case no tolls were paid except by vessels using the Gloucester and Berkeley canal. Notwithstanding this rivalry however, so enormous is the cost of insurance demanded and paid for vessels navigating the Bristol Channel, that the railway would upon the whole have been able to carry cheaper than by water, and of course with much greater expedition. It has been stated by an authority well versed in the subject, and possessing an intimate knowledge of this part of the country, that the amount paid annually for insurance by vessels navigating the Bristol Channel, would more than pay the interest of constructing a railway on its bank.

Both these projects for railway communication died for want of support, and to this end, the apathy of those locally interested, has very greatly contributed. Thus it happens, that the communication with Ireland, instead of being completed by railway from London to our western shores, is still effected by way of Bristol and the Aust Ferry; and hence it is that Government, provoked at the delay and inconveniences of the present land communication, is now determined to make Bristol the port of departure for Ireland, and accordingly the terminus of the route by land. The people of Gloucester, of South Wales, and the border counties, will now see to what result their own apathy and negligence have brought them. One of the principal sources of traffic is in a fair way of being removed—one which a railway might have confidently depended on commanding, and one, which once established by steam-packets from Bristol, will probably never be restored to any route by land. Gloucester has from the first been grossly backward in profiting by the great railway movement. The spirit of her merchants, which had raised her to one of the first ports in the kingdom, which called into existence her splendid docks and great ship canal to Berkeley, seems strangely to have died away at a time when the march of improvement presented an opportunity which may never again be realized. An important position was assigned to Gloucester as a part of the railway system in its origin, but so superior was the spirit of Bristol, and so much more enlarged were the views entertained by her important commercial corporations, that Gloucester was left far in the back-ground; and has consequently sunk into an obscurity from which she may never emerge. The conduct of the four great commercial associations of Bristol in reference to the first proposal for the Great Western railway, furnishes an important lesson to those who would in future secure to themselves such important advantages. It is known that the Society of Merchant Venturers, the Chamber of Commerce, the Bristol Dock Company, and the Bristol and Gloucestershire Town Road Company met together for the purpose of promoting the projected railway communication with London; and for the furtherance of this object, each of the companies munificently subscribed £500 towards the prosecution of the survey and the defraying of preliminary expenses. To those whom it may concern we would say,—go ye and do likewise.

DR. REID'S LECTURES AT EXETER HALL.

COLOURING PROPERTIES OF VEGETABLE SUBSTANCES.

JULY 6.—Clorine is the great agent employed for changing vegetable colours; by means of it some mixtures are rendered colourless, some are rendered white, and in all, in the course of time, the colour will be destroyed. The effect of clorine, then, is to decompose colour. But there are other substances, such as alum, which powerfully combine with colouring matter. When an infusion of Brazil wood or of litmus is made in alum-water, and an alkali is added, the acid of the alum is disengaged, and the earth alumina which is contained in the alum falls down, and carries the

colour with it. This is a direct chemical combination between the earth and the colour.

Oxides of tin and of other metals are called mordants, because they attach colour to cloths, and cause it to become fixed and incapable of being washed out. When cloths, previously to being coloured according to various patterns, have been impregnated with a metallic oxide, they will retain colour without being affected by many causes which would otherwise destroy it.

Dr. Reid then showed the method of producing coloured patterns of various kinds on cotton cloths. In doing this he used a wooden pattern covered, on which the oxide of tin was rubbed over in powder: on applying this to the cloth a faint impression was made; and on immersing the cloth in a basin of colouring matter, the colour fixed at once upon the part on which the metallic oxide had been pressed, and on no other part of the cloth.

Although the colouring matter may temporarily fix to other parts than those covered with the oxide, yet clorine will immediately bleach such parts quite white, but will have no effect in destroying the colour of those places to which the metallic oxide has been applied.

Such is the method adopted for fixing the colours of all kinds of printed cottons, and wherever the use of the metallic oxide has been omitted, the colouring matter will invariably wash out. The metallic oxide employed in the experiment is a visible one, in order to afford a better illustration—invisible oxides, however, are frequently employed on the large scale in factories, those of tin and antimony being most commonly in use.

To show the method of destroying the colour of cloth by means of clorine, the Doctor produced a piece of red cloth, which he termed a compound of cloth, oxide, and colouring matter. This may be decomposed by anything which will destroy the texture of the cloth or decompose the colouring matter. To effect the latter a wooden pattern was moistened on its surface with an acid, and applied to the cloth. The cloth was then immersed in a bath of clorine, and immediately the part which had been touched by the acid was bleached white, the rest of the cloth retaining its original red colour. This effect was produced because the oxide of that part had combined with the acid and left the colouring matter without protection; this being attacked, therefore, by the clorine, was immediately destroyed, and the cloth then presented a white pattern on a red ground.

RESPIRATION AND THEORY OF VENTILATING.

The air which we breathe is first received into the lungs. It then passes into an immense number of interior cells: it is not known how many of these cells there are, but it is known that if the surface of the cells in an ordinary man were exposed and spread out into one area, it would exceed 400 square feet. Such is the extensive provision made by nature for the constant supply of fresh air to every individual. On the average about 20 respirations are made in a minute, or upwards of 28,000 every day and night. At the same time that the functions of the lungs are thus constantly in exercise, an action is increasingly going on all over the surface of the body: in every square line of this surface there are about 50 apertures, or upwards of 7000 in a square inch; by means of these the atmosphere exerts a great influence upon our system. The surface of the lungs and the functions of the surface of the body reciprocate with each other, and if by injurious clothing or otherwise you diminish the action of the surface, the lungs take on an increased action, and you bring on disease. The remedy then is to restore the action of the surface, and this must be done before health can be restored. Some persons by various causes have so diminished the functions of their skin, that an immense, and of course a very dangerous, action is going on in their lungs. In such persons the product of respiration is very different from that in other people; for whereas this product should not in a healthy subject amount to more than three or four per cent. of carbonic acid, it amounts in them to six or seven per cent., showing the much greater supply of atmospheric air which they require. The state of one individual from season to season is not more variable than that of different individuals at the same time from this cause. Individuals in fact differ in their appetite for air as much as in their appetite for food.

In the doctrine of ventilation there are two fundamental points—two questions to be separated; namely, the quantity of air that an individual can live on, and the quantity that is desirable; also the supply which serves at one temperature may be inadequate at another. Bear these two points in mind.

The atmosphere is composed of carbonic acid and moisture, and loaded with substances exhaling from animals and vegetables. A continual current of this air is playing around the human frame. On the great scale the air circulates in currents from the equator to the pole, and in the most minute forms of animal life the same action is exhibited. Ventilation would thus go on naturally in all situations, if it were not for the mode in which dwellings and buildings are constructed. You should not obstruct the free course of ventilation. It is generally known that carbonic acid is heavier than common air; and so it is when in large quantities, for it will then always sink to the bottom. But it is not so with the carbonic acid which is liberated during respiration: this is always lighter than atmospheric air, and hence it is that the vitiated air from the lungs always ascends.

Dry rot is frequently occasioned by carbonic acid from the lungs. The Doctor here produced a specimen of timber completely decayed, which he had himself taken from the upper part of an old house. Nothing is so powerful as carbonic acid for producing vegetation: this is the great cause of dry rot extending in buildings, where the richness of the nourishment supplied from the lungs powerfully induces the growth of vegetable matter. Some few months ago the Doctor, when examining the roof of a church in which the timber was affected by dry rot, observed that one of the steps of the ladder by which he was ascending was also unsound, and on grasping it in his hand it crumbled into powder. All this had been effected by the carbonic acid with which the atmosphere inside the church had been loaded by the breathing of the congregation. In many houses we find the timber of the walls, the furniture, paintings, libraries, all destroyed by dry rot. In such cases, if you drive away the carbonic acid which the lungs have given out—if you take away that pabulum which gives to vegetable growth so much of its fertility, you will save all these from the destruction of dry rot. Now the carbonic acid will be driven away by a current of air;—hence the remedy which should be employed to prevent its accumulation. It is often difficult to destroy the dry rot in situations where the materials are prone to the development of vegetable growth. There are substances, however, which absorb the offensive matter of dry rot, or combine with the substances affected by it, and destroy the vegetation. Dr. Reid here exhibited a piece of canvass, of which one part had been

dipped in a metallic solution and the other had not. Being placed in a situation favourable to the growth of dry rot, the one part had been vigorously attacked and was now quite destroyed, the other had remained quite sound. The solution here employed was muriate of tin, for the use of which Sir William Burnett had obtained a patent. The Doctor concluded this lecture by illustrating the construction and action of the air pump.

July 13.—The preliminary lesson to the juvenile course was continued this evening, on the subject of alkalies and earths. Ammonia is an alkali obtained from all animal and vegetable substances exposed to heat without the access of air. This alkali is composed of hydrogen and nitrogen, and is extensively produced in coal tar. It is distinguished from all other alkalies in being gaseous; it is hence called in commerce the volatile alkali. Ammonia has the property of destroying the effects of deleterious acid, and if we breathe air which is loaded with carbonic acid, ammonia neutralizes the acid, and renders the air wholesome; hence its use as a smelling salt.

Alumina and lime are soluble in various acids: sand, however, is not so, and on account of this peculiarity some say that sand, or the earth silica, should rather be placed among the acids than the earths. Sand, however, can be rendered soluble by mixing it with potassa, and may be rendered gaseous by different acids. The Doctor here produced a whitish liquid which had been thus derived. Sand and potassa were heated together to redness, and formed glass; this glass was boiled in water and became fluid. This effect took place because too much potassa had been used in the manufacture. The Doctor then added sulphuric acid to this solution of glass; the acid immediately combined with the potassa, and the sand was separated: thus the sand which had been combined with potassa to form glass, which had afterwards, owing to its mixture with potassa, been dissolved in boiling, was now again in its original condition of silica. One of the great and peculiar features of sand, then, is, that it is soluble in water when combined with potassa.

THE LECTURE.—VENTILATION.

The great fundamental principle of ventilation is, that there should be one road to let the air in and another to let it out, and that there should be valves upon these roads, so that when the weather is cold you may check the admission of air, and on the other hand when it is warm, and the constitution is excited, and the air is in a different physical condition, you may open the valves and let in a different quantity. Every one knows that death inevitably ensues if you do not give enough air; but it is not generally considered that the quantity of air required even by the same individual is exceedingly variable. The state of the constitution, for instance, varies with the seasons; it varies after meals, and after heavy exercise. If these variations, then, exist in the appetite for air, even of the same individual, you must obviously have a power of meeting extremes—you must consider quantity as well as quality.

In great public buildings, where large assemblies of people take place, it is often found that the power of both the speakers and the hearers is injured by bad air. In order to remedy all this, certain simple principles require to be known. There have been great defects in most of the projects for effecting ventilation. One man has a patent for letting the air in, another for letting it out; but there is no general system for meeting great variations, and no plan for balancing correctly the ingress and egress of the air. How much air will you give an individual to sustain the power and vigour of his action? How are you to manage the building so that this quantity may be supplied? Why, treat it as you would anything else in physical science. In order to do this you must first have correct measurements of the quantity required in extreme cases, and next, you must have a power of adjustment, by which the supply may be varied between the extremes.

In numerous buildings where arrangements for ventilation have been made, there are great variations in the supply required. Individuals are often retained in such buildings for 4, 5, 6, or even in extreme cases for 10 or 12 hours, and this sometimes in a particular position. The numbers also are very fluctuating; and it would be very inconvenient to those who are passing in and out, if you could not meet the variations of the external air, and those of the building within. Here, then, is an essential difference from the case of ventilating an ordinary dwelling-house. There are here extreme transitions to meet. The atmosphere which is quite pleasant for 30 or 40 people, would be intolerable for 500. A portion of air is always moving round the human body according to its specific gravity. This must be varied according to the circumstances of the moment. It is one thing when one person is occupying an apartment, and it is a very different thing when the floor is covered with human beings. Dr. Reid has found by experiment, that 79 men could stand on 81 square feet of ground. Boys and young persons, however, will stand on much less space; two of the former may often be packed into every square foot. The supply of air, then, must be accommodated, not to the area of the room, but to the number of persons who occupy it. The quantity of air must be regulated as you regulate your diet and your clothing. It is not sufficient, in a case of ventilation, to say that the air comes in here and goes out there—its quantity must be measured.

There are two modes by which air may be introduced into an apartment: these form two grand distinctions in the practice of ventilation. Suppose that you blow air with great force into any apartment, then you know that you could no sooner open a door or a window than the condensed air would have a tendency to go out. Here you have the air made similar to that which is outside. If you blow in enough not only to fill the room, but to make it pass out from every aperture, it must be more dense than the air outside. In that case the air in the room is said to be in a state of *plenum*. Suppose, on the other hand, instead of blowing air in, that you draw or suck it out, what is the principle of this? that at some window, door, or ventilating aperture, you push away the external atmosphere, and diminish its pressing power. If you do this, the air from the other side will be pressed in, because the atmosphere presses equally on all sides. This process, then, of making the air thin, by drawing it out at one place, tends to admit it at another place. This kind of ventilation is on the *vacuum* principle. The distinction between this and the *plenum* principle should never be lost sight of. As to the means of inducing movement in the air, this depends upon the variation of pressure. If you make the air light by heat, the heavier air will sink under and push it out. Secondly, you may induce movement of the air by the action of mechanical power. You may also do it by electrical power; but this latter, although the agency is peculiar, reduces itself to a mechanical power. You may cause movement of the air

by steam, by heat, or by any mechanical operation. You may do it with a bellows, a scoop, or a fanner. All these resolve themselves into modes of effecting variation of pressure.

Dr. Reid here directed attention to a glass model of the House of Commons, and explained that the position of that building is such, that the state of the external atmosphere is by no means of the best description. The air for the supply of the House has to be taken from the ground. This is objectionable, because there are many impurities in the air of London near the surface. It had been found by experiment, that a square inch of gauze intercepted 500 tangible pieces of soot. This would show the impurity of the London atmosphere. Many have proposed to use ice for cooling the air which is brought in for ventilation. It may be cooled, however, without any such expensive process. For instance, if we sit in air at a temperature of 65°, it is very pleasant; but if air at this temperature were moving against us with the velocity of a hurricane, it would be very cold. The temperature of the human body is always at 98°; hence it is easy, by giving a velocity to the air coming in contact with us, to cool it to any reasonable extent. Hence it will appear that the thermometer is not a proper index of the effect of air, without taking its velocity into account. There are certain peculiarities connected with the ventilation of the House of Commons. It is important to give every individual a sufficient quantity of air. If you let this quantity of air in by one channel, those who are near the opening will be much inconvenienced, as they will receive the full force of what is meant to be distributed amongst all. Each, then, should be put in the way of that current which supplies himself alone. Again, it is obviously desirable to have the air ascending. Then you must make a space or chamber below to contain the air. We have seen that it will not do to have tubes conducting the air from this chamber. It is necessary, then, to make the whole floor porous, so that the air may pass from the chamber through the floor into the House. Having done this, it is obvious that each individual will be subject only to the air which is necessary for himself, and in this way little offence will be produced.

By means of the model, the Doctor then explained the mode of ventilating the House. Below the whole floor is a vaulted space, called the Equalizing Chamber. At one end of this is an air chamber, into which air, either hot or cold, moist or dry, may be introduced. The natural mode of allowing the vitiated air to escape would have been by the roof; but there being objections to this, the air is conducted from the roof, or rather from a space below the roof, down to the foot of a shaft or chimney, in which a fire is lit. This fire causes a constant circulation of the air. Those who are in the gallery of the House do not breathe the air which has been respired by those below, but receive a supply of fresh air, which passes from the equalizing chamber through hollow walls. The Doctor showed very clearly the cause of ventilation, by allowing smoke to pass from the equalizing chamber through the body of the House. It was then seen through the glass to be travelling down the communication to the base of the shaft, and at last passing away from the top of the latter. It was also shown how the supply could be instantly increased, whenever a fluctuation of the the number of persons in the House required an additional supply of air. The Doctor dwelt forcibly upon the importance of being able to regulate this supply in such a case as the House of Commons, where the members fluctuate from 30 or 40 to as many as 500 or 600 upon particular occasions.

July 20.—If we look to the state of modern times, connected more especially with the history of architecture, we shall find that many important subjects have made great progress which formerly were little understood. Amongst the principal of these may be classed drainage and ventilation. How little were these understood till Priestly pointed out the structure of the air, and Black investigated the nature and properties of carbonic acid! When these important subjects are not attended to, they are calculated to reduce the intellectual power as much as they injure the physical system. Agreeable as the situation of London may be, there is no place which presents a greater field for improvement by means of drainage and ventilation. Take for instance, the neighbourhood of Westminster, where the numerous sewers which discharge themselves into the Thames are provided with sluices or doors which are closed by the tide at high water. There, at this time, and particularly during extraordinary tides, the action of the drainage is stopped for a considerable period, and the offensive gas produced in the sewers and drains is not able to find exit. You have already heard how carbonic acid is formed from the decomposition of animal and vegetable substances, and you will see how much of this injurious gas will be produced from the stagnation of the impurities by which the sewers of London are occupied. Carbonic acid is extremely injurious to persons as well as to premises. In order to prevent its accumulation, the air should be drained from such sources, and propelled through them as well as the water. Take, for instance, the case of sunk stories, where food is decomposed in a single day, while in the upper parts of the same house the decomposition would not take place in three or four. The air in such cases should be drained upwards. This drainage of the air demands the first investigation in all new architectural buildings. Provision should be made for draining it from all kitchens, cellars, and passages.

In all the principal houses in London gas is excluded from the superior rooms because it would injure the pictures, but it is common in the kitchens, and in parts of the basement story. The proprietor of a house so circumstanced would appear to be little cognizant of the fact, that whilst he is deprived of the superior light afforded by the gas, he is subject to all the injurious effects of its incombustible products, which, unless drained off from the burners, will pass freely up to his highest chambers. When the air is not drained off at all, or even where the ventilation is imperfect, those products of the air which ought to be drawn off remain, and hang about an apartment and its furniture, giving to it that old and decayed smell which indicates incipient dry rot.

The drainage of air is the first great source of improvement in architectural construction. The second is the employment of iron and fire-proof cement. By means of these conjoined you are now able to construct buildings which shall resist fire and decay.

With respect to gas, his (Dr. Reid's) opinion was, that the time must come eventually, should no new discovery eclipse all our present knowledge of the subject, when gas will be used in every house. There are great advantages connected with gas, both as a medium for diffusing heat and light. It is supplied in a continuous stream: the amount of supply may be regulated at pleasure, or may be instantly cut off, and once in action, it may, if you please, be continued for ever. In summer time also gas is capable of affording heat more economically than coal. It is not here meant that weight for weight, and price for price, so much heat can be produced from gas as from coal, but that you may apply a certain amount of gas

to produce a certain amount of heat which requires regulation, or cutting off at particular times, more economically than you can employ coal for the same purpose. In using gas you have no ashes, and you have no grate to heat, so that you do not sustain that great loss which is taken from an ordinary fire by the conducting power of a heavy iron grate; and in addition, you save all the heat which in a common fire-place passes up the chimney. These are the prominent advantages of gas. The gas companies themselves are the greatest opponents to it, because they neither produce a coke of the best quality nor gas itself of the best quality. It is known, that if after producing a certain amount of gas from coal you continue to heat the coal, you will obtain more gas, but its quality will be very inferior; and at the same time that you are deteriorating the quality of the gas you are hardening the coke by this extra heating, and rendering it less valuable as a fuel. The coke when thus injured is not easy to kindle, not so pleasant when in combustion, and does not produce that lambent flame which proceeds from coke when not deprived of its last particle of bitumen. If the gas companies, however, would produce a better coke, it would be found remarkably superior to that which they now furnish in all these particulars, and you might then induce people to burn coke in their houses instead of coal, and thus in time prevent, or at least greatly diminish the smoke of London. The great point to be considered with respect to this change is, that while you would have better gas and better coke on the one hand, you would also, at the same time, have more comfort and greater economy. There are innumerable instances where, for manufacturing purposes, a brisk and powerful heat is required for a moment of peculiar intensity, and in supplying this kind of heat, gas is decidedly the most economical means, as you have the power of causing an instant cessation of its heat at any moment. The general structure of buildings would be much improved by means for removing the products of combustion. Dr. Reid here exhibited a fire-place in which coke alone was to be used. In order to prevent smoke from fuel, you must either have the flue perforated by many small apertures, or you must employ smokeless fuel. Some persons say that coke produces a sulphureous smell, and whether this be called sulphureous or carbonic acid it is still objectionable. It should be remembered, however, that coal itself becomes coke during the process of combustion. The method by which the burning of coke alone in a fire-place should be effected, is to allow no air to enter except in front. There should also be a damper fixed in the chimney, so that the draught of the latter can be regulated by opening or partly closing the damper as may be required. The fire is therefore converted in a temporary manner into a furnace. In a fire-place of this kind the whole is of brick-work except the iron which is necessary for the bars in the front. In this respect its heating properties will be very superior to those of the common fire-places, where a massive iron grate sends a great quantity of heated air up the chimney. On the other hand, a brick grate radiates outwards, and little of the heat is lost. New means have been adopted in modern times for conveying heat in flues, a practice greatly superior to that of constructing the old fire-places, from which the heated air mounted upwards and left the room quite cold below.

Ventilation is intimately connected with the communication of sound. There are some rooms capable of containing several thousand persons in which a speaker can scarcely be heard. When an individual speaks he respires according to the nature of the apartment; and so various is the kind of respiration required for speaking in different rooms, that while in some an ordinary breath or inspiration will last a whole sentence, in others it is found that the breath is almost gone when a single word is spoken. There is a third class of rooms in which a speaker is so much affected by having the syllables reflected and cast back in his mouth, that he experiences the same effect as if some one were mocking him by repeating every thing he utters. The existence or the absence of these defects in a room depends upon its architectural structure, as in some rooms the walls are calculated to reflect the sound, while in others the sound passes through the walls as readily as if they were of open trellis-work.

The intellectual power is much affected by having to attend to the mechanical part of speaking. The power of communicating sound through the atmosphere, is known to be very great. When the air is still, the human voice may be heard for miles: one case is recorded, in which it was heard at Gibraltar from a distance of 10 miles. In still evenings in this country, it may often be heard 1, 2, or 3 miles. The cry of watermen has been heard distinctly several miles. The shrill call of the fisherman, consisting of a prolonged and musical note, may be heard 5 miles. The island of Inchkeith is 5 miles from Edinburgh, and the voices of the fishermen in the island are frequently heard there. The roll call at Edinburgh Castle has been heard 20 miles. Admiral Stothard had informed Dr. Reid, from his own personal observation, that the sound of cannon may be heard from a distance of 300 miles; as he (the Admiral) had himself an instance of this, where he had heard all day long the noise made at a foundry, in proving cannon 300 miles distant.

Music on the water is always most distinct and beautiful, when there is no returning echo; sound is always most beautiful when pure, and hence the superior effect of music on the water, where there is no echo to mar the next sound, but every note and note are in themselves pure, clear, and distinct. In this case, then, there is no reverberation of sound. It is necessary to distinguish between purity and mass of sound. Some rooms approach in effect to music on the water, and are called silent rooms. Others, again, are so highly sonorous, that if you produce an intonation in them it will last for a long time. Such is the defective construction of many public buildings, that only the first few words of a discourse can be heard distinctly, the next are more obscure, and very shortly the voice becomes inaudible. It is obvious, from what has been said on the communication of sound, that if the walls be made silent, there is no limit to the size of rooms, while on the other hand, if the walls be sonorous and reflecting, the sound is soon lost even in small rooms. In some rooms, if the window or door be open, you can hear a speaker much better in the open air than in the room itself.

It is remarkable that the kind of architectural construction which is best adapted for sound, is also best adapted for ventilation. The Doctor here exhibited the drawing of a large series of rooms, all ventilated by means of one chimney, or shaft, in the centre; the fresh air is taken in from below, and in every chamber there is one opening for the introduction of air from the fresh flood below, and another for the egress of the vitiated air. The means of applying a system of general ventilation to a large mass of buildings, was then shown by the sectional drawings of a great square, and the Doctor explained that, according to this plan, an extensive system of ventilation had been resolved on for some new and important buildings at Liverpool.

COLLEGE FOR CIVIL ENGINEERS.

The annual distribution of prizes to the students at this admirable Institution took place on Wednesday last, on which occasion the President, his Grace the Duke of Buccleuch, presided. His Royal Highness the Duke of Cambridge was present, and took a lively interest in the proceedings of the day.

After viewing the models and drawings which were arranged by departments in various rooms, and which were highly creditable to the students, the company assembled in the large hall, and the Duke of Buccleuch having taken the chair, the business of the day was opened by the Earl of Devon reading the annual report of the Council, prefacing it by a few remarks expressive of the pleasure with which he presented it to the supporters of the Institution :—

THE REPORT.

"The Council, in addressing the patrons and friends of the Institution, at the close of another session, have much pleasure in expressing their satisfaction at the improved state of the College, and their conviction of its increasing prosperity.

The Institution during the past year, has had to contend with many and great obstacles to its progress—obstacles of so serious a nature as for a time to have threatened the destruction of the College, but which have happily been overcome, and the Council, regarding the Institution as a national object, have been encouraged to persevere in their labours, and have the gratification to state that their exertions have been repaid by the daily increasing support of the public, and the general good conduct of the students.

The Council have to announce that, at the ensuing session, the Professor of Natural Philosophy will commence his course of lectures, that the department for civil engineering and construction will be so enlarged as to enable the Professor to carry out his course with a series of practical experiments—that, in consequence of the munificent donation of the President, his Grace the Duke of Buccleuch, of a six-horse condensing engine, the works in the machinery department will be continued with increased facility—that the report of the Professor of Chemistry being highly favourable, it is in contemplation to enlarge the course—that in the department of geodesy, the surveying operations will be continued with unabated industry, and that the same attention will be paid to the other branches of study. The Council have great pleasure in stating, that the examination in mathematics has been highly creditable to the students, and the examinations in the other departments very satisfactory.

The Council take this opportunity of returning their thanks to those gentlemen who have, by their kindness, afforded the students an opportunity of visiting public works in progress.

In conclusion, the Council have full confidence in the continued good conduct of the students, which must greatly contribute to the well doing of the Institution.

On behalf of the Council,
Devon."

College, Putney,
July 20, 1842.

At the conclusion of the report, which was received with much applause, the distribution of the prizes took place—prizes rendered more valuable by the kindly manner of his Grace the President, who addressed each of the prizemen; and by the interest exhibited by the royal visitor at his right hand.

The following is a list of the prizemen, and, from a careful reading of the various printed questions, we can safely pronounce these prizes, which were awarded according to the recommendation of the professors, to have been well deserved by the students, as were the drawing premiums, the specimens of which were beautifully executed :—

Mathematics.—*First Class.* Kingsbury, Arnold, Scott.
Second Class. Shillito, Holmes, Jenkins.
Third Class. Grant, Young, King.

Chemistry.—Kingsbury, Price.

N.B.—Warden papers mislaid, classed among prizemen.

Civil Engineering.—*First Class.* Dobree, Minchin.
Second Class. Sale, A. J. Mahon.

Machinery.—Scovell, Gill, Coates, Stopford.

Geodesy.—Curtis, (certificate of honour, having declined the prize) Arnold, Ibbetson.

Landscape Drawing.—Ibbetson, Arnold, A. J. Mahon.

Perspective.—Kingsbury.

Geography.—Bridgeman, W. Lloyd, A. J. Mahon.

French.—C. H. Brown, Shillito, Allan.

German.—Arnold, Patterson, C. H. Brown.

Best Note Book given by the Hon. Mr. Howard.—Scott.

Principal's Prize for Good Conduct.—Matthias.

Professor's Prize for Attention and Progress in Professional Branches.—Curtis.

The following students also received certificates of honour :—

Chemistry.—Bridgman, Berney, Dobree, Sterling.

Civil Engineering.—Devenish.

Machinery.—Ibbetson, Priston.

Geodesy.—Hill.

Good Conduct.—Devenish.

Having delivered the prizes, the Duke of Buccleuch expressed himself much gratified at the marked improvement and progress of the establishment. His Grace also took occasion to allude to the pleasure with which he had bestowed the prize for good conduct, after hearing the manner in which it had been determined, and listened to the high eulogium which had been passed upon the good conduct of the students.

The Duke of Cambridge in few, but most forcible, terms, pointed out to the students that talent alone was not all that was necessary to ensure them success and distinction, and that the report of the day must be followed up if it were to produce all those good effects which he so sincerely desired to see, and which were desired by all the friends and well-wishers of the Institution.

Lord Devon expressed his gratification at the present state and progress of the Institution, and paid a high compliment to the Committee for their unremitted exertions to promote the interest of the College.

The company having promenaded the heathful and beautiful grounds of the college, partook of an elegant *dejeuné*. The healths of her Majesty the Queen, the Duke and Duchess of Cambridge, the Duke of Buccleuch, Sir Allan M'Nab, Sir I. Brunel and the prosperity of the college were drunk with much enthusiasm.

Sir Allan M'Nab's health was proposed by the Earl of Devon, as a most distinguished officer, holding a high official appointment in another hemisphere, and capable therefore of bearing testimony to the value and importance of such a course of education as was here afforded in training young men for efficient services in foreign countries.

Sir Allan M'Nab, in returning thanks, expressed in strong terms the sense which he entertained of the general benefit which must result to the country with which he was more immediately connected, from the services of persons so trained; and stated, that the arrival of such persons in Canada would be hailed with satisfaction by all who were interested in the prosperity of the colony—that he himself should be the foremost so to welcome their arrival; and he trusted that if any of those young gentlemen whom he had seen that day, or any who might hereafter be educated at that college, should visit Upper Canada, that the Council or College authorities would kindly give them an introduction to him, that he might have an opportunity of proving the sincerity of what he had just stated.

Sir I. Brunel's health was drunk with much enthusiasm, as an engineer who had done so much in that science.

In returning thanks, he referred to what Sir A. M'Nab had said of the importance of engineering in Canada, and spoke of the progress of that country by means of engineering during the last half century; the construction of public roads and means of communication, where before the traveller had to convey his pack on his back, the rearing of villages and towns, and even the establishment of omnibuses, which had not been known in London more than a few years. He then alluded to iron as a means of wealth, and although of small value in itself, it had produced more gold than any other metal. Silver and gold, he said, are to be met in abundance on every table, but in the state which we there behold them they remain, and are wholly unproductive, whereas iron is always in a state of progressive improvement, and goes on still producing more and more to add to the stock of national wealth.

Both Sir Allan M'Nab's and Sir I. Brunel's addresses made a deep impression on the company, and convinced all of the importance of the education given at the College in a national point of view.

The beauty of the grounds and the present management of the Institution were subjects of general remark and approbation.

[We rejoice to find that the college is now succeeding so admirably, and that the country is becoming every day more sensible of the value of such an Institution. It would have been highly mortifying had the result been otherwise—mortifying to our pride as a nation, the foremost in intellect, in science, and literature—mortifying to our boasted sense of superiority in commerce and manufactures, and doubly mortifying to our ancient inheritance of sound and sterling wisdom, as a people, if such a comprehensive and bold exertion to establish the occupation of the Civil Engineer at once socially and politically in the first rank as a profession had seemed likely to fail in carrying out this object. When it is understood that the system of training up engineers at an independent establishment interfered considerably with certain private interests which it may not be necessary here to dwell upon, it will not excite any surprise to be told that petty cabals sprung up with all the rapidity of mushroom-growth, to oppose it at the very onset, that cunning intrigue and and jealous manœuvring were not wanting amongst the opposing factions, and lastly, that scandal lent her unworthy aid to belie and misrepresent in many tortuous forms the generous and public-spirited motives of the earliest friends and supporters of the infant college. To these it must be a great consolation then to reflect that the institution, which is destined probably to send forth her talented and accomplished sons to work out the noblest physical designs of providence over the whole earth, has continued calmly and quietly, and therefore with much dignity and native superiority, to rise beyond the reach of the envenomed shafts which ignorance and malice, self-interest and avarice, had aimed for her destruction.

It has been the opinion of many persons who fancy themselves specially endowed with a very keen and penetrating vision, that the sources of employment for engineers generally, far from being on the increase, are actually declining, and that there are in fact more engineers existing at this very time than the world will ever require for the next fifty years. All this is a mistake engendered amongst men whose minds are like the microscope, with the range of observation very limited, and the few facts which fall within that range magnified to a degree of importance far beyond what they are entitled to. There can scarcely be a more direct instance of the working of this microscopic kind of intellect than when we hear persons arguing, that because all or most of the railways of this country are now completed, the labours of the engineer are nearly at an end, and that far from affording employment to a new generation of engineers, the demands of society will barely serve to keep the present members of the body from absolute inactivity. How little acquaintance have the men who thus argue with the untiring spirit of enthusiastic perseverance which takes root in the bosom of the true engineer. How little can they calculate on the effect of that working, heaving mass of learning and genius which is now every day more and more devoted to research in physical history, and is every day penetrating deeper and deeper into all the secrets and processes of nature, and careering with the most restless activity amid all the forms and changes of inorganic matter. It was a very beautiful piece of imagination to suppose that the new world rose from out the deep to reward the daring energy of Columbus; one would at least be better supported by the general experience of mankind, were he to say that a thousand channels now unthought of even in dreams will bring employment in every country for the labour and talents of an accomplished race of engineers. Granting that the bold high spirit of enterprize which animates the merchant princes of our land could ever wane and languish in times to come, can we suppose that a body of men, enjoying the command of that mass of knowledge which a thorough engineering education embraces, would have no power to rouse the slumbering energies of mankind, and keep them ever active in the grand pursuit of more successfully adapting the earth for the habitation of man, and for the support and enjoyment of human existence.

At present the engineers of most countries are comparatively an insignificant part of the whole population; and however eminent some few individuals may be in the most highly civilized of European countries, it must be confessed that as a body the engineers hold no very prominent rank in the scale of society, and that they fail to exercise any important influence in the origination of successive improvements. It would extend these remarks to an unintentional length, if we should indulge in any suppositions as to the causes of this. One thing is clear, however, for the future; namely, that whenever we can boast of a numerous learned and spirited body of men, united by some ties more or less strong in the same career for the prosecution of useful and substantial improvements, we shall surely thenceforth have little cause to complain that their influence is not feebly felt in the great movements of society; for according to all human probability, an association under such conditions would possess a more

undivided command over the world than its past history has ever witnessed.

What gave the Church of Rome her mighty power throughout the dark reign of the middle ages? The sacred character of her doctrines, and all the mysteries of her spiritual and ceremonial rites, contributed not half so much to this as did the concentration of all the learning in the world amongst the devoted and loyal body of priests who stood around her altars, and propped the giant fabric so long and so successfully. An effect analogous to the unlimited power which these possessed over the world evidently awaits the future association of men in whose hands all the resources of art, and an almost boundless number of those which nature herself employs, are employed with familiar ease and ready skill. Who can doubt that such a power, whenever it comes to be acquired, will be used for the noblest purposes?

Pure self-interest, indeed, would point to these as most in accordance with her dictates, and when we thus find the utmost fame and honour and benefit to individuals associated so inseparably with the general good, we cannot doubt that the whole combination which gives rise to such conditions, together with all or most of the separate members of the combination, are in themselves good, excellent, and worthy of being persevered in.

If there were any need to convince the suspicious and sceptical by reference to actual details, that there are many varieties of brilliant career before the future engineer, we should point to the colonies of the South Sea, where, in New Zealand, Van Dieman's Land, many parts of the Australian continent, and in several smaller groups of the South Sea islands, the field of employment is almost boundless, from the first labours of the surveyor, who first traces a straight line through the untrodden wild, up to the most splendid and enduring works of engineering skill, which all these places will require before the lapse of many years. Even America—even British America, furnishes a striking instance of what remains to be done in the prosecution of great works of engineering; these requiring, as well as in the less civilized islands of the Pacific, extensive preparations by the surveyor, and afterwards labours of great extent, in order to bring the country to enjoy the indispensable advantages of good land and water communications. Colonel Philpotts's report on the canal navigation of the Canadas, lately reprinted in a separate form from the papers of the corps of Royal Engineers, brings forward a great mass of valuable information relating to the great works required to complete the communication from Lake Erie to Montreal, for which it is anticipated a very large sum will be advanced by Government. The map which accompanies this paper of Colonel Philpotts, shows that an immense tract, comprising many thousand square miles, in the province of Upper Canada, has never yet been surveyed; and this alone would form rich employment to a very large body of field engineers.

India, again, presents a very fine field for the rising engineers of this country. Railways of great extent are in contemplation in that country, and there is every prospect of a great demand for engineers being kept up for many years.

It has been proposed by one, whose sound judgment and extensive fund of information entitle his opinion to some respect, that the government should institute a cadetship for students from the College for Civil Engineers, who go out to the colonies of Great Britain. The advantages of the education acquired at the college are already so much appreciated, that the Governor of Upper Canada has promised immediate employment to students bringing out certificates from the college.

The field of employment for engineers at home is by no means limited. For instance, a great extension of the railway system has yet to be made in England, while many important main lines must shortly be put in execution in Scotland and Ireland. In the latter country several large works are now in progress, amongst which may be mentioned the improvements of the Shannon and the embankments of Lough Surlby, near Londonderry.

The practicability of acquiring immense tracts of land by embanking against the sea, requires the aid of the interests immediately concerned in so desirable an object, and this aid once secured, an extraordinary amount of service would be required from the engineers of the country. Agricultural engineering, also, is a subject of vast importance, and one which should be strenuously advocated by those who are directing the studies of our future engineers. We hope and expect to see before long, that this branch of practice will have become an integral part of the engineer's profession. If we look at all these sources of employment at home and abroad, and consider that there are many others of great importance which we have not named, there surely can exist no reasonable ground for apprehending that a deficiency of future practice for engineers will be generally experienced.—Ed.]

REVIEW.

The Theory and Practice of propelling through Water, with Observations on the comparative Resistance offered by Water to Bodies moving through it at different Velocities. By Henry Booth, Liverpool. 8vo. 46 pp. London: J. Weale, 1842.

It is probable that no branch of practical science has more extensively engaged the attention of mathematicians and philosophers since the days of Sir Isaac Newton than the department of hydrodynamics, which relates to the resistance opposed by fluids to bodies moving through them. At the same time it is necessary to confess, that the most profound speculations of science and the most ingenious applications of mathematical analysis have seldom been found more completely at variance with practical truth, as exhibited in actual experiment, than in the theories they have furnished for determining the laws of this resistance. Whilst some have founded and built up a theory without once appealing to practice or to experiment to test its soundness, others have been led away by the fallacious authority of a few isolated experiments; and if they have thus succeeded in avoiding the monstrous errors of the purely theoretical, they have been perhaps the more dangerous class of teachers, because they have more pertinaciously clung to the errors by which their doctrines were encumbered.

It has been reserved then for this, which is peculiarly the age of practical truth, to experiment on a scale of sufficient magnitude to give confidence in the results established; and all that appears now to be wanting is a comprehensive handling of the subject by men of sufficient mathematical attainments, to reduce the heterogeneous mass of experiments into a system of order and regularity, which shall give forth a series of standard and fundamental laws on this interesting subject. We propose, before noticing the results of modern experiment, to give a hasty glance at the labours of the earlier authorities.

Newton made experiments upon balls or globes moving through water at different velocities and at different depths below the surface. His object was principally to determine the resistance due to the simple inertia of the fluid, and the result which he arrived at on this subject has probably never been contradicted on good grounds by any succeeding author.

Rejecting everything but the simple inertia of the particles, Newton determined that the sum total of the motions of these particles, estimated in the direction of the motion of the body or in that of the stream, will be in the duplicate ratio of the velocity.

Now this law, which, we repeat, has never been found at variance with experiment, has been strangely perverted; and although applying only to bodies wholly immersed in water, has been taken as the basis of theory for determining the resistance to floating bodies where many other causes conspire to retard their motion than the pure inertia of the particles of water. When a law of this kind in any branch of practical science is extended by the bungling suppositions of unskilful successors to cases which it was never meant to embrace, there is no room for wonder that it fails to accord with the results of distorted and exaggerated experiment.

But probably the law of Newton's, which has since been found to be the most at variance with practice, is that which relates to the increase of resistance according to the increasing obtuseness of the angle of incidence. According to this law it was held, that the velocities being equal, resistance varied in the duplicate ratio of the sines of the angles of incidence. Now in whatever way this law was determined, whether by experiment, or from purely theoretical considerations of the way in which the particles of a fluid act in presenting resistance, it is quite certain that subsequent experiments of great nicety made by the Academy of Sciences have completely demolished all that part of the Newtonian doctrine which related to the resistance of wedges or wedge-shaped prows moving through water. For example, it was found that a rectangular box moving through the water without a prow, that is, presenting a flat surface or an angle of 180°, met with a resistance of 10,000; and the same box, when furnished with a prow in the form of a wedge, having an angle of 12°, met with a resistance of 4000 lbs., whilst according to the theory this latter resistance should only have been 109 lbs. Scarcely could a more complete contradiction be imagined; and a proportionate variation from theory was observed with intermediate angles of incidence.

Not more successful were the attempts of Daniel Bernouilli to develope practical laws for the resistance of fluids. Indeed, we find him delivering on one occasion a theory which he accompanied by the announcement that it gave a resistance four times greater than experiment; and hence it could scarcely be expected to have found much favour amongst practical men, or to have thrown much light upon the practical part of the subject. Notwithstanding all the elegance of the demonstrations, and the ingenuity of analysis by which the writings of Bernouilli were distinguished, he left the question of increased resistance in proportion to the increased velocity of a body moving through a fluid just where he found it.

The labours of Euler and D'Alembert were principally theoretical, and they appear to have arrived at no practical conclusions of much value.

The experiments by Borda and by D'Ulloa were of limited extent, and were not conducted with sufficient distinction between the resistance which was due to the inertia of the water and the additional resistance which was caused by the accumulation of a wave in front of the floating body. D'Ulloa appears to have greatly exaggerated the resistance which his experiments had determined, as he very greatly exceeds the statements of all other experimentalists.

Du Buat probably deserves the credit of having first undertaken experiments of such a kind as to inspire confidence in their results. These experiments are far too extensive and elaborate to be capable of condensation within any reasonable limits. They were directed principally to a determination of the pressure exerted by the fluid upon every part of the body immersed in it; and they showed clearly that the total resistance to the motion of a vessel will be diminished by simply adding to her length, without altering the form either of her bows or stern. In accordance with this determination, it is known in the modern practice of ship-building that by lengthening the midship section of a vessel, her power of carrying sail is increased together with her capacity for stowage, while at the same time her speed will be greater, owing to the diminished pressure upon her sides. In popular language it might be said, that a greater length occasions a more rapid and more uniform velocity of the current from the bows to the stern, and that the pressure is thus diminished upon the sides.

The experiments of the French Academy have been already alluded to. Whilst they overturned the Newtonian theory in so far as the angle of incidence is concerned, they served to confirm the law of increased resistance as the square of the velocity of the moving body. It should be observed, however, that in these experiments it was simply sought to determine the *vis inertiæ* of the water; and hence, although floating bodies were experimented upon instead of bodies wholly immersed, the necessary deductions were made for the resistance of the wave which was raised in front, and for the pressure which this produced upon the sides of the box in its course to the wake, in order to fill up the hollow left there. In this respect, the French Academy agrees perfectly with Sir Isaac Newton, whose determination had been made with respect to bodies wholly immersed; and notwithstanding the ridicule with which modern experimentalists have assailed this theory, it is probable that it still holds good where restricted to the conditions for which it was originally prescribed. It is necessary to remark, however, that the experiments of the Academy were made at the very slow velocity of 2·73 feet English, or 1·86 miles per hour. Had greater velocities been adopted, the difficulty of reducing the gross resistance to that which was due to the inertia alone would have been greater, while the coincidence with theory might not have been so perfect.

The experiments of Colonel Beaufoy were of immense extent, and comprised solids of almost every possible form. They were printed by his son, Henry Beaufoy, esq., for private circulation, in a large quarto volume, in 1834. The deduction from Colonel Beaufoy's experiments with respect to the law according to which the resistance increases, is this—that for small velocities, such as two miles an hour, the ratio of increase of resistance is a little greater than as the square of the velocity; and for greater velocities the ratio gradually diminishes, till, at the velocity of eight miles an hour, it is rather less than the duplicate ratio or the square of the velocity.

The experiments of Mr. Scott Russell on some of the Scotch canals in 1833 and 1834, were probably amongst the first which systematically and extensively disputed the old law of increase in

the duplicate ratio, and served to show that, in canals at least, where a wave is produced in front of the boat, the latter can be made by a momentary exertion of concentrated power to mount nearly to the top of this wave, and in this position is carried along by the same power which had been required for a much slower velocity when she had been deeper immersed in the water. Mr. Russell's experiments showed, that in deep water, and at slow velocities, the resistances followed the duplicate ratio; but as the velocity increases, the resistance increases in a greater ratio than as the square of the velocity. This, however, continues only up to a certain amount of speed, beyond which the resistance suddenly ceases to increase in that ratio, and continues, according to the depth of the fluid, to increase in a less ratio.

If we conceive the velocities in Mr. Russell's experiments to be represented by horizontal abscissæ, and the resistances by vertical ordinates, the curve drawn through the extremities of the latter will therefore not be of the parabolic order, which it would be if the resistances increased in the duplicate ratio of the velocities, nor will the line be straight at first, as it would be if they increased directly as the velocities, but it will be a curve rising abruptly above the parabolic line to a certain point, then falling off in its rate of descent till it intersects or tends to meet the parabola, the exact nature of the curve depending on the nature of the channel and the depth of water in which the resistances are experienced. Mr. Russell's experiments will be found in the 14th volume of the Transactions of the Royal Society of Edinburgh.

Mr. Macneill's experiments, published in the first volume of the Transactions of the Institution of Civil Engineers, will be known to most of our readers. The following were the conclusions which Mr. Macneill arrived at with respect to the increased resistance :— "1. That in the wide and deep canals, the tractive power was observed to increase with the velocity, but not in any uniform ratio. 2. That in the shallow and narrow canals, the increase of tractive power had a limit at a certain velocity, and under certain circumstances even decreased with the increase of velocity; so that it appears probable, that if the size of the canal bear a certain proportion to that of the boat, there is a certain velocity at which a boat may be drawn on a canal with a minimum tractive power. This velocity on the Monkland and Paisley canals, with boats like the Zephyr and the Swift, appears to be about nine miles per hour."

The experiments, then, of Mr. Macneil and Mr. Russell appear to establish the same kind of results; but it is important to observe, that these experiments, directed as they were to the practical elucidation of the subject, and conducted with all the advantages of having the real boats and real canals to experiment upon, are yet not to be considered as affording a refutation of the old law of resistance according to the duplicate ratio. If we take a very light floating body, of the form best adapted for skimming over the surface of the water, force it along with great velocity till it raises a considerable wave in front of it, and then, by a sudden exertion of power, cause it to mount on the top of that wave, and keep up or increase the velocity, now aided by the momentum of the wave on which the body is floating, it is obvious enough that we shall derive phenomena of increasing resistance widely at variance with those which Newton and his immediate successors determined by the kind of experiments we have already glanced at. The subjects of their experiments were immersed in water, were moved at slow velocities, and nothing was taken into account but the inertia of the particles of water. Their theories, too, were founded on the same bases, and therefore it is not fair to place them in comparison with modern experiments, in which the conditions were widely different. It is true that modern experiment alone has directed itself to the practical question, because it is not one kind of resistance only which has to be known and considered, and which it is sought to diminish, but every kind of resistance opposing the motion of bodies through the water. To modern experiment, then, much is due, for it grapples with the subject in all its reality—it drives away all that is visionary, and fixes in our minds correct notions of the whole resistance which under different circumstances of place and velocity do actually oppose the motion of floating bodies. All that we have to complain of, and wish to guard others and ourselves against, is, that petty spirit of innovation which lends itself so readily to the demolition of ancient doctrines and opinions on the authority of a few hasty and ill-digested conclusions.

The pamphlet before us consists of two parts, the first being intended for an examination of the received theory of resistance to floating bodies moving through water, with an exposition of the author's views of the fallacy of this theory; and the second part is occupied by the description of a most singular contrivance, termed by the author a Propeller, to be used in steam-vessels instead of the paddle wheel.

In bringing forward the theory at present entertained on the subject of resistance, Mr. Booth indulges with considerable triumph in a notion which appears to be mainly the creation of his own fancy, namely, in what he terms the octuple ratio, and takes some credit to himself for pointing out the fallacy of the supposition on which this theory is founded.

The doctrine which Mr. Booth here attacks is this : that supposing any given power be required to drag a floating body at a given velocity, then eight times that power will be required to drag it at twice that velocity. "Such," says the author, "is the theory of comparative resistance of water at different velocities, propounded by various writers on mechanics in the last quarter of a century, and recognized by engineers and men of science in the present day."

Mr. Booth, in the first place, takes some pains to show how very reasonable this theory is. But although by the term octuple ratio he intends us to understand, that to produce a double velocity, eight times the power must be employed, he first introduces us to a theory, which he says is sometimes expressed by the term of the *quadruple ratio*. "It is said, that if a given resistance is offered by water to a body moving through it at a certain velocity, if that velocity be doubled, the resistance will be *four-fold;* and the rationale of the quadruple ratio is thus explained:— If a body be forced through the water ten miles in the hour instead of five miles, the increased resistance will be four-fold; because the body must in the first place impinge on *twice* the number of particles of water; and, secondly, it must impinge on each particle with *double the force*, which constitutes a four-fold resistance." Now this appears all quite reasonable and philosophical; and however opinions may differ upon the conjoined effect of the contact with twice the number of particles, and the blow against each particle being given with double the force, there is at least nothing mechanically absurd in the notion, that a four-fold resistance is the result of these combined causes. But mark what follows by way of explanation of the cause, which at once doubles this four-fold resistance, and creates what the author calls octuple ratio. "But to overcome a four-fold resistance, it is further said,

that *eight times the power* will be required, because the four-fold power must move twice as fast; and by experiment it is found, that if the power employed be a weight attached to a cord passing over a pulley, if 2lbs. moving through 10 feet in a given time, be required to draw a body through the water ten feet in the same time, 8lbs. will be required to draw the body through the *same space in half the time;* but in that case, as the weight itself must move with twice the velocity, its duplicate speed represents double power. That if its speed be regulated as at first, and while the weight passes over the original *ten* feet, the body be made to move through the water *twenty feet*, which may be accomplished by doubling the size of the pulley over which the power passes, to which the body is attached, the weight or power in that case must be doubled; and 16lbs. will be required instead of 8lbs., being eight times the first power, moving through the *same space in the same time*, to propel a body through the water *double the space in the same time.*"

Now either Mr. Booth himself believes in the accuracy of this explanation, or he advances it as the opinion of others, which, disbelieving himself, he finds himself called on to challenge and disprove.

Immediately after the last quotation we have given, follows the paragraph, "Such is the theory of the comparative resistance, &c., propounded by various writers," &c. Now we want to know who are these writers—who are these engineers, and who are these men of science who propound and recognize this theory. Undoubtedly Mr. Booth could furnish a long list of practical and scientific individuals, who entertain this theory, since he appears both here and in other parts of the pamphlet to take it quite for granted that such is the received and almost universally acknowledged theory. Let us examine for an instant what it is which Mr. Booth here imputes to the men of science and the engineers whom he has so greatly misrepresented. First, it is said the resistance occasioned by a double velocity is fourfold, and then it is said that, as the power to overcome this fourfold resistance must move with double velocity, the power must be doubled on this account, making the whole power eight times as great as that required for half the velocity. Truly his is a most singular piece of logic: here it is in another form: Four times the power are required in one case to overcome a resistance, but as this power moves twice as fast, it is not four times, but eight times. By what species of magic is it that four is thus converted into eight? Suppose a single horse can draw a coach three miles an hour, and that four horses can trot with the coach at six miles; then, according to Mr. Booth's argument, four horses are not sufficient to trot at six miles, but eight horses will be required. First, it is exactly the work of four; then not an ounce less than the power of eight will suffice. Let the explanation of what Mr. Booth calls his octuple theory be examined, and see if it be not exactly represented by this case of the horses, and we shall be astonished if such another example of calculation could any where be found. When a power is employed which is just sufficient to overcome a given resistance, if that resistance be doubled, trebled, quadrupled, &c., the power must be also doubled, trebled, quadrupled, &c., the increased resistance being, in fact, the measure of the increased power. Now, if a boat moving at two miles an hour oppose three, four, or five times as much resistance to the propelling power, as when moving at one mile, then the propelling power must be increased three, four, or five times, as the case may be; and when you have so increased the power to overcome increased resistance, you have done with it.

After this specimen of the reasoning which composes the theoretical part of this pamphlet, we shall be excused for not dwelling on Mr. Booth's own notions of resistance, which, as far as we can perceive, are not at all at variance with this system of doubling the power. The principal thing which he seems to doubt in the received theory, is, whether the particles of water are struck with double the force, when a double velocity is given to the moving body. Indeed, he seems to think it quite natural and reasonable to suppose, first, that the power has to be quadrupled because it is to move twice as fast, and also that it should be again doubled for the self-same reason. When you have first quadrupled the power, surely you have done with it: its amount is then fixed and determined, and you must not again double it, on account of the same conditions which you have already amply fulfilled by first increasing it at all.

In addition to the valuable theoretical information which the author promulgates, there is an experimental treatment of the subject which we must not omit to notice. This part consists of no less than six experiments: the first two of these confirms what is called the octuple theory; the third shows that the power for double velocity was $2\frac{1}{2}$ times that for single velocity; the fourth agrees with the quadruple theory, but we are not confident whether this agreement is after or before the doubling process has been applied; the fifth and sixth experiments agree with the third. Behold the conclusion and summary of the experimental part:—

"I shall not trouble the reader with other experiments of a similar kind, tending to the same results. According to the law of friction as regards solid bodies, this species of resistance is considered the same at all velocities (twice the speed requiring twice the power.) In the foregoing experiments on the water about two and a half times the power was required. The odd *half-power* may be ascribed to the extraneous causes,* to which I have before referred, and principally, in the present case, to the swell of the water in the trough in front of the boat occasioning increased resistance, and, of course, requiring increased power, not according to a fixed and predetermined ratio, but according to the varying circumstances of the particular case."

It is possible that we may on this occasion have remarked at greater length than appeared necessary upon a production, which, professing to be the "Theory and Practice of propelling through water," is in reality neither the one nor the other, and not capable of conveying the least information on either subject. One apology for doing so is this, that amidst the great mass of works which issue from the press at the present day, it is an important service to the professional man and to the student to point out which amongst them are really possessed of merit, and which, on the other hand, are entitled to no more courteous designation than that of downright arrant trash. The time of our readers must be valuable—economy is also a consideration—and we shall at least pay so much respect to that which is really worth reading and worth buying as to hold up to contempt, without scruple or disguise, those professedly scientific or professional productions of the press which are worth neither the one nor the other. Such is the book before us; it is called "The Theory and Practice of propelling through Water," and many a student who might derive information on this very interesting subject would

* If any of our readers should have any curiosity to know what these causes are, we must refer them to the book itself, and we should recommend an early order to be given, otherwise the information will have to be sought amongst the slops of the fishmonger, or the firkins of the butter-merchant, to whose use its pages seem to be inevitably and speedily foredoomed.—REVIEWER.

have no means of knowing whether this were in reality a book capable of teaching him something, or one entirely worthless, or possibly one which, if he read it at all, would do him mischief by infusing erroneous notions. Such undoubtedly would be the effect of this book if it were read by uninformed students, supposing they were not previously warned of the silly nature of its contents.

We have, we think, said nothing about the second part of this pamphlet. It describes what the author terms an improved method of applying mechanical power to steam navigation. This improved power is proposed as a substitute for the paddle-wheel, and consists of a huge flat frame to be worked through an arc, with its broad side against the water. This is called a Propeller; and the strokes given with it are to be concentrated to one of great power when moving against the water, while the return or back stroke is to be given by a very quiet slow motion.

There is certainly something very ingenious in the mode by which these two strokes of the Propeller are effected, and although, in the absence of experiment, of which no mention is made in the description, we should hesitate from pronouncing a definite opinion either way, there may yet be something in the application here proposed capable of furnishing ideas for future improvements in the propelling power of steam vessels. Letters patent have been taken out for the invention; and notwithstanding the lame and clumsy attempt at theory and practice which the author indulges in, we do wish him success with his propeller, and shall await with some interest the result of experiment upon its power as compared with the paddle-wheel, against which we are free to admit there are many and grievous objections.

The second part of the first volume of their "Transactions" has just been published by the Royal Institute of British Architects. The two parts compose a volume of which the Institute may well be proud; for seldom has a more splendid work been added to the literary treasures of any country. Having received this book rather late in the month, we defer any remarks upon its valuable contents until our next number, when we hope also to lay before our readers one, at least, of the admirable professional papers of which it consists.

ARCHITECTURAL DESIGNS.

In presenting to the notice of our readers one of the designs furnished in the late competition amongst architects for the New Infant Orphan Asylum, at Wanstead, we have not been actuated by any wish of holding up that design to the disparagement either of the one selected by the Committee, and now in the course of adoption, or of the numerous other designs which were submitted to their decision.

We deem it not an unimportant branch of our duty occasionally to bring under public notice those designs by professional men of standing and repute, which may have been submitted by them for public works, under circumstances which they could not avoid. Such we have reason to believe was the case with the author of the present design, and it has been at our own particular request that he has placed it at the disposal of our pages.

We do not for a moment intend to advocate the system of architectural competition; so far from it, we hope in a future paper to show its pernicious tendency, both with regard to its degenerating effects upon the profession as a body, and its unhappy results in those miserable piles in the form of *cheap edifices*, y'cleped new churches, asylums, schools, and union houses, in many of which their perishable materials, and their incongruous style of architecture, present a constant source of regret to the enlightened architect and the discriminating public.

We cannot, however, withhold our surprise that so little effort has emanated from the profession, as associated under the titles of The Royal Institute of British Architects, The Architectural Society, The Surveyors' Club, or other bodies of combined influence and talent, to trace the history and expose the evils of public competitions for architectural designs. Not only does the fame of architecture as a science, embracing the most elevated and noble efforts of the human mind, the reputation of Architects themselves as following so dignified a profession, but also the interests of the public at large, loudly call for a vigorous, earnest, and united denouncement of the hydra monster that now strikes at the very existence of all that is excellent, pure, and chaste, in the study and practice of architecture.

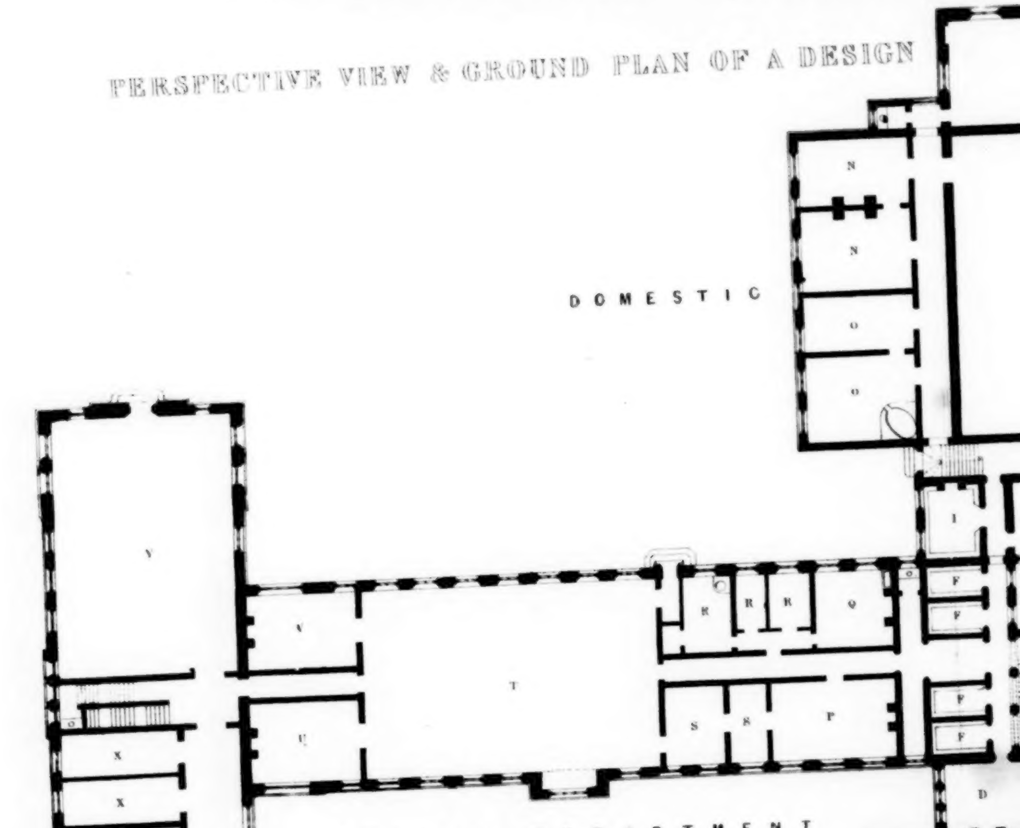
Shades of the illustrious "Archi-tectons" of Greek and Roman temples, whose proud enduring marbles yet live to tell of the bygone glories of your classic age!—noble band of brother freemasons, whose mysterious sacred edifices remain the glory of our church and father-land, and teach us how to rear a God-like sanctuary!—departed worthies of a more modern school, Palladio, Jones, and Wren!—revisit not this blighted age, except to look upon your own immortal work!—for there hath fallen upon our times scarce a fragment of your mantles, and *Ichabod* is written upon all our doings!!

It is true that, in the year 1839, a Committee was appointed from amongst its members by the Royal Institute of British Architects, to consider and report upon the subject of public competition in architecture; and many valuable suggestions were thus brought into notice. We are not, however, aware that any remedial measures have resulted from this or any other body of the profession; and we believe that, although they have done something towards partially exposing the system, yet nothing has been proposed to put it down. That it can and ought to be put down, we hope to be able to show; and though we cannot quite coincide in opinion with a clever little pamphlet*, that "the *best architects never do compete*," (because experience shows us that they are sometimes so situated that compliance is unavoidable,) yet do we most heartily concur in the advice contained in the same number of that work, and would say in its own words to architects, "Remember the dignity of your profession, and scorn to disgrace it by entering into unworthy contests, and by mean concessions to popular customs or individual prejudices. If you for your part *reject competition, the system soon must fall*, since increased architectural knowledge will not much longer tolerate ignorant and faulty designs."

The design forming the subject of the accompanying Plate, is divided into the several departments requisite for the objects of the Institution, viz.:—

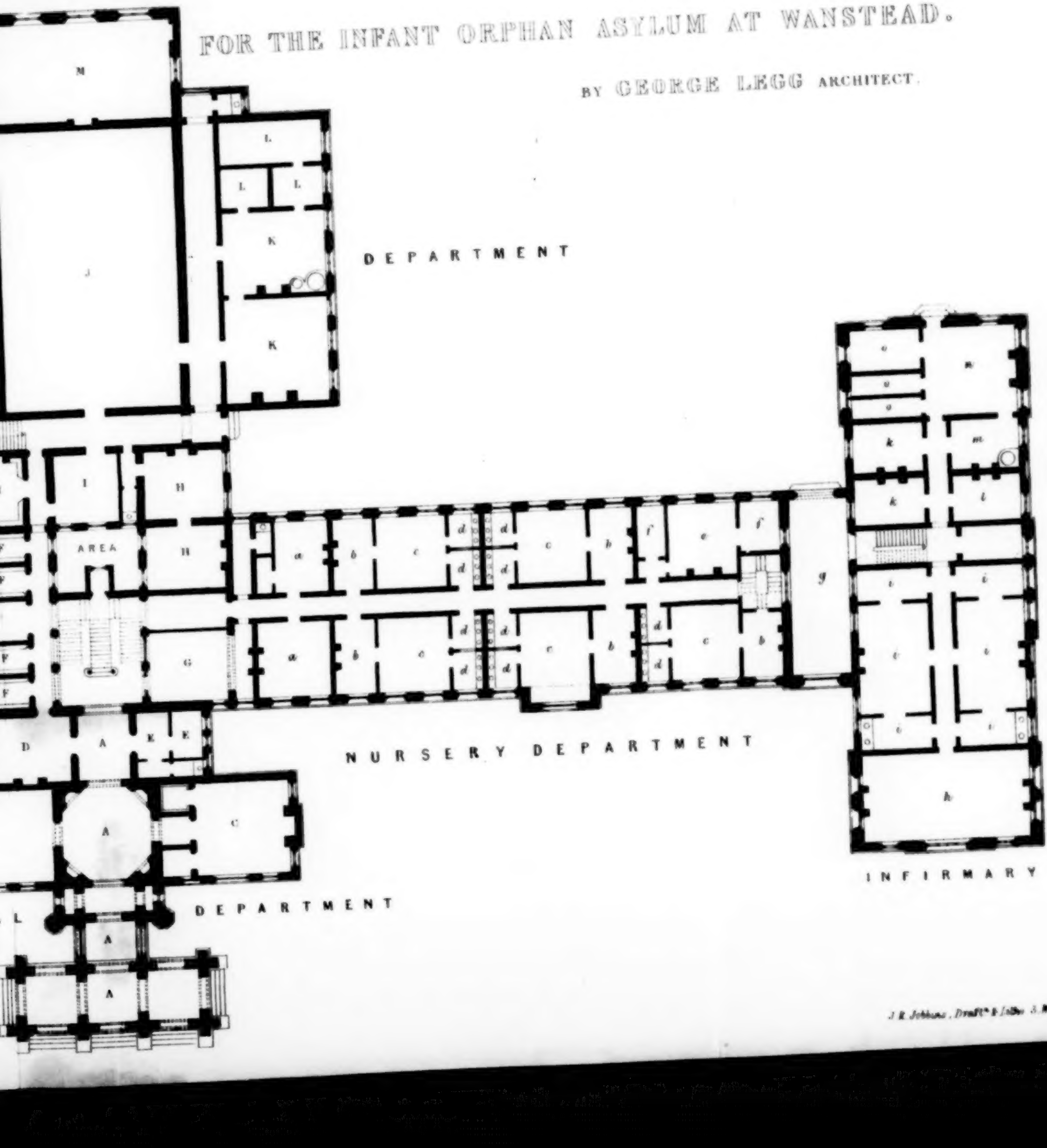
* "The Ecclesiologist," Nos. VI. VII., published by the Cambridge Camden Society. This Society appears to deserve the best support and influence of the profession for its praiseworthy efforts to preserve the true style and spirit of our Ecclesiastical Structures.

PERSPECTIVE VIEW & GROUND PLAN OF A DESIGN



FOR THE INFANT ORPHAN ASYLUM AT WANSTEAD.

BY GEORGE LEGG ARCHITECT.



J R Jobbins, Draftsm & Litho 3 Warwick Ct

The General Department,
The School do.,
The Nursery do.,
The Domestic Department, and
The Infirmary.

The detail comprises the following accommodation :—

REFERENCE TO GROUND PLAN.

A A A A, Arcade, vestibule, and hall; B, Committee room; C, Secretary; D, Matron; E E, Lobby, washing-room, &c., for committee; F F F F, Matrons store rooms; G, Waiting hall; H H, Reception day and night wards; I I, Principal stores and weighing room; J, Refectory for 200 children; K K, First and secondary kitchens; L L L, Larders, pantry, and stores; M, Work-room; N N, First and secondary laundress; O O, Bakehouse and breadroom; P, Master's sitting room; Q, Master's kitchen; R R R, Offices to do.; S S, Book and anti-room; T, School room for 200 children; U U, Class-rooms for 30 children each; V, Play-room; W, Sitting-room for assistants; K K K, Day washing, shoe and cap rooms; *a a*, Sub-matrons, sitting and bed room; *b b b b b*, Day rooms, for 10 children each; *c c c c c*, Night rooms for do.; *d d d d d d d d d d*, Night and washing closets to do.; *e*, Sub-matron's kitchen; *f f*, Scullery and pantry to do.; *g*, Open avenue to detach infirmary from main building; *h*, Convalescent ward; *i i i i i i*, Sleeping rooms for 12 children each, with night and washing closet; *j*, Surgey; *k k*, Nurse's room; *l*, Bath room; *m*, Washing room; *n*, Kitchen; *o o o*, Scullery, pantry, and stove rooms.

PRESERVATION OF TIMBER—EFFECTS OF KYAN'S PROCESS.

TO THE EDITOR.

SIR,

MY attention has been attracted to a letter on Dry rot, in the last number of your useful Journal, in which your correspondent W. G. states his belief that the bichloride of mercury (or corrosive sublimate) is an ineffectual agent in the preservation of wood, in consequence of its solubility in water. It is the opinion of most men who have written on this subject, that in order to preserve wood, it is necessary to coagulate the albumen present in it, an opinion which is amply borne out by the fact, that all the substances successfully employed for this purpose, possess this property. When corrosive sublimate is employed, a peculiar change take place, the sublimate is decomposed at the same time the albumen is coagulated, the result being an insoluble compound of mercury, either in the state of calomel or oxide, with the albumen. It is therefore obvious that your correspondent is in error, when he supposes that water can remove the mercury.

The insolubility of the protochloride of mercury (or calomel) renders it impossible to impregnate wood with it, even if it had any action on albumen which however it has not. The subject of destroying the effect of Kyan's process on timber by immersion in water has been carefully experimented on by Professor Faraday, the results of which he gave in a lecture delivered by him at the Royal Institution, and from this lecture I make the following extract:—"Respecting the permanency of corrosive sublimate when once applied, his opinion was, that the sublimate was not likely to be removed and its effects destroyed, and nothing was to be dreaded from a noxious atmosphere, because chemical combination had taken place with the albuminous matter of the wood; it occurred to him to take some of the prepared canvass, and by washing it thoroughly several times in water, to ascertain if the sublimate could be removed from the cloth. This substance was taken in preference to wood, because it would more easily allow the removal of the new chemical combination, if that could be effected. For if the properties of the compound would resist the application of water in a piece of canvas, they would of course do so in timber. Where the substance combining with the sublimate was contained in the pores of the sap vessels, the result of this experiment was, that after repeatedly washing the prepared calico in water, he was unable to obtain any portion of mercury. The mercury however was easily separated on the application of nitric acid by destroying the cloth, which showed that it had been in combination; but there was no reason to suppose that it could be washed away with water. The analysis by Fourcroy and Berzelius shows that the bichloride becomes a protochloride when it combines with the albumen."

The comparative strength in different kinds of timber after being subjected to the preserving process does not appear to have been sufficiently considered until the recent experiments of Mr. Hyatt of Gloucestershire; he found that resinous timbers, such as larch, were rendered comparatively useless by the process, whereas oak, beech, &c. were much strengthened; a piece of the latter which before the process sustained a weight of 240lbs. was afterwards found capable of bearing 305lbs. with the same deflexion.

I am, Sir, yours, truly,

GEO. WHITE.

2, *Bentinck Street, Manchester Square.*

LONDON ELECTRICAL SOCIETY.

THE Society held their first meeting at their apartments in Cavendish square, on Tuesday the 19th, when the Secretary reported to members that the library is now arranged for their use; and that added to their other privileges, they are now allowed free access to the exhibitions at the Polytechnic Institution. The business of the ordinary meeting commenced with a short note by a member, H. Prater, Esq. on the solution of gold in muriatic acid by voltaic agency, in which he traced evidence against the identity of electrical and chemical affinity. A long communication was then read by the Hon. Secretary, Mr. Walker, "On the action of lightning conductors," in which he arrives both by inductive reasoning and by direct experiment to the following conclusions: 1st, that the discharge of a Leyden jar does not resemble a flash of lightning; and, therefore, that Leyden jars should not be employed in lightning experiments:—2nd, that the discharge of a prime conductor does, in all essential points, resembles a flash of lightning; and is therefore admissible in such experiments:—3rd, that the wire, on which sparks are thrown from the prime conductor, represents a lightning rod:—4th, that sparks will pass from such a wire, and therefore from a lightning rod to vicinal conducting bodies: and lastly, that these sparks may be prevented by connecting the vicinal bodies with the rod itself.

If the writer has even succeeded in nothing beyond establishing the first proposition, he has done much: he has as it were weeded out from the field of enquiry an immense mass of extraneous experiments, and the very experiments to which have given birth to so much conflicting opinion. But if his concluding experiment be orthodox, he has demonstrated something to which the former is but a stepping stone; he has established the fourth proposition, and has shown that "the lateral spark" is an attendant on badly arranged conductors. We should neither satisfy our scientific nor our unscientific readers, were we to give a partial notice of each experiment, but can safely refer to the paper itself. We may mention that the author congratulates himself on having, during this investigation, had access to the largest electrical machine in the world, and has employed quantities of electricity, somewhat resembling flashes of lightning themselves. A paper by Martyn Roberts, Esq. member, F.R.S.E. was read, on a new battery for blasting rock, the plates of which are zinc and iron, and the arrangement is such as to bring into action all the metal without counter currents. The mode cannot be well understood without a diagram. Mr. Weekes's paper was then read, being the monthly Register for June, of the Electro-Meteorology of the Atmosphere.

ON PREVENTING THE CRYSTALLISATION OF IRON.

TO THE EDITOR.

SIR,—I read with much interest in your Journal of last month the notice of an article by M. François, of the Paris Academy of Sciences, on preventing the crystallisation of iron. Some years ago I turned my attention to the same subject, and made some hundreds of experiments to determine the simplest and most effectual mode of making fibrous iron, as being the most removed from that granular fracture which generally indicates the presence of crystallisation. The results of these experiments were communicated by me to the British Association, in a paper read at the Liverpool meeting in 1838, and will be found in a greatly condensed form in vol. vi., pages 134 and 155 of the *Transactions* of that body. The object had in view by these experiments above alluded to was the formation of fibrous railway iron, avoiding as much as possible the crystalline fracture. This, after many trials, was produced with the greatest certainty, not from refined metal, but by puddling good grey iron with a portion of iron ore.

This process I patented six years ago, and it invariably ensures iron of the hardest and most fibrous quality, but has, in a great measure, been overlooked by the ironmasters, principally on account of the extra trouble and attention required to prepare the iron ore, and from the fact that a few tons less of iron per week is made from the puddling-furnace, quantity, not quality, being the primary consideration.

Since the period alluded to the subject has acquired a deeper and more intense interest (which involves the safety and lives of millions), arising from the enduring character or otherwise of the iron manufactured for the axles of locomotive-engines travelling on railways, and those used for carrying goods and passengers along the same. I am inclined to believe with Colonel Aubert, that safety lies in frequent change of the metallic molecule, by exposing the removed and vibrated axle for twenty-four or thirty hours, in a heat of about 1200° of Fahrenheit—a temperature short of procuring an oxide scale upon the surface of the iron, or injuring its compactness. This species of softening or annealing I have found in many instances, both with iron and steel, of advantage, by increasing their strength and tenacity.

Perhaps a still more effectual method would be to cause a minute, but continuous, flame of gas to impinge lengthways upon the centre of the axle, while the carriage was in motion, so as to produce a slight, but permanent, increase of temperature. This would add greatly to the capacity of the iron to resist the force of impact, and render travelling, so far as the axletrees were concerned, perfectly safe. How far this might, by the increased temperature, interfere with the necessary greasing of the axletrees, experiment alone would determine.

DAVID MUSHET.

Coleford, Gloucestershire, July 6.

MESSRS. SEAWARD AND CO.'S ATMOSPHERIC MARINE ENGINE.

ON Friday, the 17th inst., a trial was made on the Thames of a new iron steamer, built by Messrs. Ditchburn and Mare, and fitted up with an engine on a new plan, by Messrs. Seaward and Co. The vessel is 150 feet long, with only 19 feet beam, and her draught of water is no more than 4ft. 8in. The engine is on the atmospheric principle, and the first of the sort, we believe, ever applied to marine purposes. It consists of three cylinders, of 47 inches diameter, placed in a line athwart the vessel; and the pistons, which have three feet stroke, are worked by the alternate action of the atmosphere and steam, above and below. The three piston rods are connected by oscillating rods directly to cranks at different angles, so that two at least are always in action, whereby the inequality of application when two only are employed, is avoided. The pistons themselves are of a peculiar construction; and on this the working efficiency of the engine seems mainly to depend. Each piston has three grooves on its outer circumference; of which the upper and lower are for the reception of the packing, and the middle one is kept filled with steam, by the means to be presently explained. The piston has three guide rods, one of which is hollow; and within this hollow guide-rod there is a tube, which works through a stuffing-box, and communicates at the opposite end with the boiler. Steam is constantly supplied through this tube to the middle groove of the piston, as well during its ascent as descent, *and any access of air to the cylinder is thus completely prevented*, the pressure of the steam while working being at all times greater than the pressure of the atmosphere. During the trial last week, the pressure of the steam was generally about 8lbs. The engine is estimated to be of 100 horse-power.

The paddle-wheels are 16 feet in diameter; the number of floats in each 24; the area of the starboard floats 9ft. 6 × 14in.; and that of the larboard, 9ft. 4 × 14in.

The vessel (which has not yet been named) made several trips between Blackwall and Gravesend, and the engines worked throughout admirably, making generally 33 or 34 strokes a minute. In one of the trips she had a trial of speed with the *Railway*, commonly supposed to be the fastest boat on the river, from Greenhithe to Blackwall, and beat her by two minutes. Another trip from Gravesend to Blackwall was made in 1 hour and 7½ minutes, which is supposed to be the quickest passage ever made between these two points. The tide was with the vessel, but it was a low neap tide, not equal certainly to more than two miles an hour. The distance from Gravesend to Blackwall is stated to be 22 miles, so that the speed realized was close on 20 miles an hour.—*Mech. Mag.*

AMENDED INSTRUCTIONS OF THE CHURCH BUILDING SOCIETY.

(From "*The Ecclesiologist.*")

1. *Site.*—Central, with regard to the population to be provided for; dry; if possible, rather elevated, but not on a high or steep hill;—not near nuisances, such as steam-engines, shafts of mines, noisy trades, or offensive manufactories;—accessible by foot and carriage-ways, but not so near to principal thoroughfares, as to subject the service of the church to the danger of being incommoded by noise. The building to stand east and west as nearly as possible.

2. *Style and Form.*—No style seems more generally suitable for an English church than the Gothic of our own country, as developed in its successive periods. The Norman (or Romanesque) style is also suitable, and offers peculiar advantages under certain circumstances, especially when the material is brick. The Society earnestly recommend that, in the proportions and great features, as well as in the details, good ancient examples should be closely followed.

For Gothic *churches*, the best form is either the cross, consisting of a nave, transepts, and chancel, or the double rectangle, composed of a nave, with or without side aisles, and of a chancel. In a *chapel*, the single rectangle is also suitable; the length being *at least* twice as great as the breadth. If the funds do not suffice to complete satisfactorily a design, otherwise eligible, or if the circumstances of the neighbourhood render it probable that, at no great distance of time, the building may be enlarged, it is better to leave a part of the original design, as, for example, side aisles or transepts, to a future period, than to attempt the completion of the whole design at once in an inferior manner. In such a case, the temporary walls and fillings up of arches should be so built, as clearly to show that they are temporary, and that the building is incomplete, but at the same time not without due regard to ecclesiastical propriety.

3. *Foundation.*—To be surrounded, if requisite, by good covered drains. If the soil wants firmness, the walls may often be better secured from partial settlements by spreading the footing on each side, than by deepening the foundation, or resorting to more expensive works.

In all irregular or doubtful soils, concrete is recommended for the foundations, in preference to any other material.

No interment should be permitted under a church, except in arched vaults properly constructed at the time of building the church, with entrances from the outside only; nor should any graves be made within twenty feet of the external *wall*.

4. *Area.*—It would tend much to the preservation of churches, and render them more dry, if a paved open area, not less than eighteen inches wide, were made round them, and sunk six or eight inches below the level of the ground about the church, with a drain from the area to carry off the water.—Or the same objects might be attained either by turning a segmental arch from the wall outside the footing, or by bedding in the wall a course of slate in cement.

5. *Basement.*—The inequalities of the ground, the dampness of the soil, &c. often render it desirable to have crypts under a church. They should be of a massive construction, turned upon semicircular or segmental arches, resembling the early examples, entered only from without.

6. *Floor.*—To *sittings*, wood; to open spaces, or chancel, stone or encaustic tiles.—If not undervaulted, it may be freed from damp by brick rubble, flints, ashes, or furnace slack, laid to the depth of twelve or eighteen inches under the floor.—Allowance should also be made for the future rise of the surrounding burial ground; the floors of many churches, originally above ground, are at this day many feet below the surface,

and have thereby become damp and unwholesome. It is desirable that the church floor should be raised at least three steps above the ground line.

The distance between the joists of the floor should never exceed twelve inches.

All wood floors should be supported on walls, with a clear space of eighteen inches in depth, well ventilated beneath.

No American timber to be used either in the floors or any other part of the building.

Flagged floors should be laid on cross walls eighteen inches high.

7. *Walls.*—To be solidly constructed of stone, either squared, or rubble, or flint; or of brick, where no good stone can be procured without great additional expense. If the walls are of brick, cased with stone or flint, to the stone or flint to be *well bonded* into the brick. As a general rule the thickness must *not be less than* as follows:—

	Square Stone of the best quality, or Brick.		Brick, faced with Flint or Stone.		Inferior Stone, or Rubble.	
	ft.	in.	ft.	in.	ft.	in.
If less than 20 feet high, and carrying a roof not exceeding 20 feet span.	1	10½	2	0	2	3
If 20 feet or more high, or carrying a roof exceeding 20 feet span.	2	3	2	5	2	6
If more than 30 feet high	2	7½	2	9	3	0

The above dimensions are given on the supposition, that there are buttresses, of solidity and form suitable to the style adopted, placed opposite the trusses or principals of the roof; where there are no buttresses, the thickness of the walls must be considerably greater.

No cement or plastering of any kind to be used as a facing of the walls, or of any external part of a church or chapel.

If a wall be built with two faces of stone, filled between with rubble, great care must be taken that they be properly *bonded together*, as the wall will not otherwise stand a partial settlement. Where good stone is scarce, a thickness, otherwise perhaps unattainable, may be secured by this method of construction.

Walls built of flint or rubble should have bonding courses of stone or brick, and stone or brick piers at intervals, approaching at least within four inches of the external face.

Whatever be the material of which the substance of the walls is made, the dressings should, if possible, be invariably of stone.

The greatest attention should be paid to the quality of the mortar used.

8. *Roof.*—The best external covering is lead, which should be not less than *seven* pounds to the foot;—or copper, of not less than *twenty-two* ounces to the foot. Blue tiles, commonly called Newcastle tiles, or stone tiles, are, perhaps, the next best covering.—Westmoreland slates are better in colour than those commonly used, but are, in most cases, expensive. All slates to be fixed with *copper nails.*

Flat *ceilings* are inconsistent with Gothic architecture. Next to a stone vaulted roof, none has so good an effect internally as an open roof exhibiting the timbers. It is desirable that this should be of high pitch, the transverse section forming or approaching to the figure of an equilateral triangle.

If a wooden panelled roof be preferred, the panelling should not be made to imitate stone.

In roofs of low pitch and wide span, horizontal tie-beams are necessary; but in other cases, where the Society is satisfied that *due* provision has been made for the safety of the construction without them, they may be dispensed with.

If the distance between the principal trusses exceed ten feet, intermediate trusses must be introduced. The distance between the common rafters should never exceed twelve inches.

Wherever the ends of timbers are lodged in the walls, they should rest in cast-iron shoes or on stone corbels.

9. *Windows.*—In Gothic churches, where stained glass is not used, the glass should be in small panes, those of a diamond shape being generally preferable.

Hopper casements are recommended, and they should be inserted in almost all the windows, in order to secure due ventilation.

Where lead lights are adopted, copper bands to tie them to the saddle bars are preferable to lead, being less liable to stretch and become loose by the action of the wind.

The very unsightly appearance often occasioned by the wet streaming down the window backs can be prevented by fixing a small copper gutter at the bottom of each lead-light, to receive the moisture produced by condensation, with copper tubes to convey the same to the outside of the building. This has also a tendency to keep the building dry, and to preserve it from decay; or the inside of the sills may be raised an inch and a half.

(*To be continued.*)

MISCELLANEOUS.

Cast-Iron Buildings.—Buildings of cast-iron are daily increasing at a prodigious rate in England, and it appears that houses are about to be constructed of this material. As the walls will be hollow, it will be easy to warm the buildings by a single stove placed in the kitchen. A three-story-house, containing ten or twelve rooms, will not cost more than 1100*l.*, regard being had to the manner in which it may be ornamented. Houses of this description may be taken to pieces, and transported from one place to another, at an expence of not more than 25*l.* In the little town of Everton, near Liverpool, a cast-iron church has been recently built, having a spire of the same material, the total cost of which was 8000*l.*; the church is 116 feet by 48; it is built in the Gothic style, and is painted in imitation of stone. It is said that a large number of cast-iron houses are about to be manufactured in Belgium and England, for the citizens of Hamburgh whose habitations have been burnt.

The Artesian Well at Grenelle.—After four months of unremitted labour, pursued with the greatest science and judgment, M. Mulot has succeeded in extracting from the Artesian well at Grenelle the first tube, which had been got down to the depth of nearly 336 yards, and had become collapsed by the pressure of the water. The passage has not suffered any injury; and the water, which remains at the temperature of 23 deg. above zero, of the centigrade scale, and 73 deg. of Fahrenheit, flows with the same abundance, sometimes clear, sometimes muddy, according as the argillaceous strata in the upper parts of the passage fall down to the bottom. A new tube has been made, with great care, of cast-iron, about a quarter of an inch thick, covered with zinc both inside and outside, and so strong, that a heavy-laden waggon could pass over it without making an impression. This tube is to be sunk down to four or five yards in the sand at the bottom, whereby there is every reason to believe that the water will rise perfectly clear, as the sand will cause a natural filtration, and purify the water from any mud it may contain; and the small stones or gravel the spring may throw up, will fall back again by their own gravity, as is the case in all wells. At the same time, the tube will prevent any of the earth of the upper strata from falling into and mixing with the water. Should no new accident occur, M. Mulot expects that the well will be completed early in the next year.—*Galignani's Messenger.*

Wire Rope for Shipping, Mining, and Railway Purposes.—We understand that a successful trial of the properties of the wire rope was made, a short time since, in her Majesty's dockyard at Portsmouth, undertaken (by permission of the Hon. D. P. Bouverie, admiral superintendent) with the view of testing its superiority over that of hempen rope for nautical purposes. The following particulars of the test, which was conducted in the presence of many distinguished and scientific persons, have been furnished by a correspondent:—"Three pieces of wire rope were put to the test of the machinery at the rigging-house, and the following was the result:—Two fathoms of hawser-laid wire rope, of 2¾ inches circumference, stretched 16 inches, and broke at a strain of 9 tons 8 cwt. 2 qrs. 19 lbs.; was placed again and further tested (having three wires broken), and broke this time at a strain of 9 tons 0 cwt. 2 qrs. 19 lbs. It was spliced again, the ends being only once turned in, and bore a further strain of 7 tons 5 cwt. 3 qrs. 19 lbs. A piece of selvagee wire rope, of 1¼ inch circumference, was next tested and broken at a strain of 3 tons 1 cwt. 2 qrs. 6 lbs., having stretched only 3 inches. Another piece of selvagee wire rope, measuring only three inches circumference, was afterwards tested, and broke at a strain of 15 tons 12 cwt. 1 qr. 19 lbs. Several pieces of wire rope were afterwards knotted and spliced in various ways, to show that there could be no objection raised on that ground."

The following table has been made by order of the late Admiralty, at the dockyard at Woolwich:—

Breaking strain.	Eql. strength.	In. circum.	Wt. per fm.	Price per fm.
8 tons....	Wire rope....	2 inches	2 lbs. 10 oz.	1s. 6d.
	Hemp do.....	5 inches	6 0	2 7½
	Chain	½ inch diam ..	16 0	4 0
24 tons....	Wire rope....	4 inches	12 4	6 7¼
	Hemp do.....	10 inches	25 0	10 11¼
	Chain	31-32 in. diam.	53 0	11 10¼
54 tons....	Wire rope....	6 inches	34 0	18 6
	Hemp do.....	15 inches	47 8	20 9¼
	Chain	1 in. 7-16th d.	115 0	24 0

This table applies only to selvagee rope, intended for ships' standing rigging, which is one-fourth stronger than hawser-laid, the latter being better adapted for railways and mining purposes.

LIST OF PATENTS.

Continued from page 192.

(SIX MONTHS FOR ENROLMENT.)

John Harrison Scott, of Somers Town, engineer, for "certain improvements in metal pipes, and in the manufacture thereof."—Sealed July 6.

George Edmund Donisthorpe, of Bradford, top manufacturer, for "improvements in combing and drawing wool, and certain descriptions of hair."—Sealed July 6.

Joseph Hall, of Cambridge, agricultural implement maker, for "certain improvements in machinery for tilling land."—Sealed July 6.

Lady Anne Vavaseur, of Melbourne Hall, York, for "improvements in obtaining images and metallic and other surfaces."—Sealed July 7.

Richard Hodgson, of Montague Place, gent., for "improvements in obtaining images and metallic and other surfaces."—Sealed July 7.

James Timmins Chance, of Birmingham, glass manufacturer, for "improvements in the manufacture of glass."—Sealed July 7.

Charles Augustus Preller, of Eastcheap, merchant, for "improvements in machinery for preparing, combing, and drawing wool and goat's hair," being a communication.—Sealed July 7.

William Fairbairn, of Manchester, engineer, for "certain improvements in the construction of metal ships, boats, and other vessels, and in the preparation of metal plates to be used therein."—Sealed July 7.

John Perring, of Cecil House, Strand, hat manufacturer, for "improvements in wood paving."—Sealed July 7.

John Bird, of Manchester, machinist, for "certain improvements in machinery, or apparatus for raising or forcing water, and other fluids, which said improvements are also applicable as an engine, to be worked by steam for propelling vessels, and other purposes."—Sealed July 7.

William Richard, the elder, of Burley Mills, Leeds, manufacturer, for "an improved method of consuming or preventing smoke, and economising fuel in steam engines, and other furnaces."—Sealed July 7.

William Revell Vigers, of Russell Square, esq., for "a mode of keeping the air in confined places in a pure or respirable state, to enable persons to remain or work under water, and other places, without a constant supply of fresh atmospheric air."—Sealed July 7.

John Peter Booth, of the city of Cork, merchant, for "certain improvements in machinery and apparatus for working in mines, which are applicable to raising, lowering, and transporting of heavy bodies; and also affording assistance in promoting a more perfect ventilation of the mine."—Sealed July 9.

Jean Baptiste Francois Jouannin, of Upper Ebury Street, Pimlico, mechanic, for "certain improvements in apparatus for regulating the speed of steam-air, or water-engines," being a communication.—Sealed July 9.

James Crutchett, of William Street, Regent's Park, engineer, for "improvements in manufacturing gas, and an apparatus for consuming gas."—Sealed July 12.

Thomas Deakin, of Sheffield, merchant, for "improvements in the manufacture of parts of harness and saddlery furniture."—Sealed July 12.

John Leandre Clement, of St. Martin's-lane, engineer, for "improvements in apparatus for ascertaining the temperature of fluids, and also the pressure of steam"—Sealed July 12.

William Henry Stirchey, of St. Petersburgh, now of Upper North-place, Esq., for "a pneumatic engine for producing motive power."—Sealed July 12.

Joseph Schlesinger, of Birmingham, manufacturer, for "certain improvements in inkstands and in instruments for filing or holding papers and other articles."—Sealed July 16.

Robert Benton, of Birmingham, land-agent, for "certain improvements in propelling, retarding, and stopping carriages on railroads."—Sealed July 16.

Joseph Barling, of High-street, Maidstone, watchmaker, for "certain improvements in producing rotary motion in machinery worked by manual labour."—Sealed July 16.

John Chativin, of Birmingham, button manufacturer, for "improvements in the manufacture of covered buttons."—July 16.

Charles Robert Ayres, of John-street, Berkeley-square, architect, for "improvements in ornamenting and colouring glass, earthenware, porcelain, and metals."—Sealed July 23.

Joseph Partridge, of Bowbridge, near Stroud, Gloucester, dyer, for "certain improvements in cleansing wool."—Sealed July 23.

Eugene de Varroc, of Bryanstone-street, Portman-square, for "apparatus to be applied to chimneys, to prevent their taking fire, and for rendering sweeping of chimneys unnecessary."—Sealed July 23.

Alexander Johnstone, of Hill House, Edinburgh, Esq., for "certain improvements in carriages, which may also be applied to ships, boats, and other purposes where locomotion is required."—Sealed July 23.

Edward Cobbold, of Melford, Suffolk, master of arts, clerk, for "certain improvements in the means of supporting, sustaining, and propelling human and other bodies on and in the water."—Sealed July 28.

TO CORRESPONDENTS.

Mr. Storey's communication will appear in our next number.

Ζητητὴς inquires as to the slopes of reservoirs, whether the practice of forming the flat slope on the inside is invariably followed. He suggests that the reverse of this arrangement, while it would in no respect alter the strength of the bank, would add materially to the capacity of the reservoir within the same superficial area, and render the land slope more valuable for cultivation, as it would lose itself more gradually in the natural surface of the ground.

This remark is certainly worthy of attention in cases where there is no considerable wash or agitation of the water of the reservoir to be apprehended, and where the surface of the water remains at nearly the same height throughout the year. Under these circumstances there could be little or no objection to the use of the steep slope on the inside, and the flat slope on the landside, whilst the advantage which our correspondent remarks on is certainly important.

Ponds and ornamental reservoirs, with raised banks, are not unfrequently made with a steep slope of about 1½ to 1 inside. The embanked reaches of a canal also from lock to lock may be considered as a series of long reservoirs, and these are commonly set out with a steep slope of 1 to 1½ to 1 inside, and 2 to 1 outside. The same construction has been followed in the side ponds and reservoirs of canals where embankment has been necessary; the object being obviously to obtain the largest capacity of basin which the surface would allow.

"Arpenteur" requests to be informed of the best books for a young man who is just commencing the study of geology. We cannot undertake to recommend a set of books as *the best*, because we might possibly, in doing so, commit a great injustice towards excellent works, which might not occur to our recollection at the moment of recommendation. Our correspondent, however, may depend upon the following as excellent elementary works on geology; Philips's Geology, in 2 volumes, being partly the Cabinet Cyclopædia; Lyell's Elements; Lyell's Principles, in 4 volumes, (a more extensive work, of which there is also an edition in 3 volumes); Delabeche, How to Observe Geology; Delabeche, Manual of Geology; Brand's Outlines of Geology. Amongst works on the geology of particular districts and countries we may confidently recommend Conybeare and Phillips's Geology of England and Wales; Mantell's Geology of the South-East of England; Murchison on the Silurian Series; Delabeche on the Geology of Cornwall and Devon; and the excellent work now in course of publication in parts, by Mr. Weale, on the Geology of England and Wales, with maps on a very large scale, reduced from the Ordnance survey.

Mr. Bruff's Engineering Field Work—the Treatise on Levelling—has been received for review, but too late for this month.

SECTIONS OF RAILWAY CUTTINGS & EMBANKMENTS.

FIG. 1.

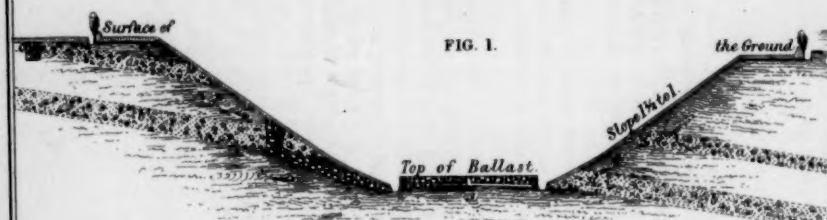


FIG. 4.

FIG. 2.

Top of Excavation & Surface of the Ground.

FIG. 5

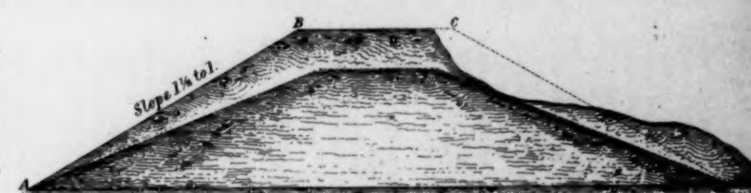
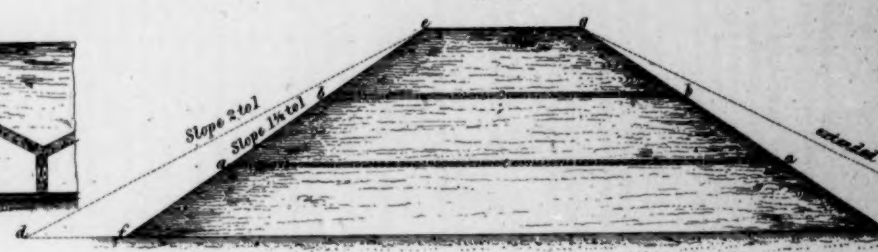


FIG. 3.

Top of Excavation

FIG. 6.



Scale 32 Feet = 1 Inch.

J. R. Jobbins, litho. Warwick Ct. Holborn.